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BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

SPRING
1952

PLANT
HORMONES

How and When
to Use and
here to Get Them

For

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NEW SERIES
. 8 NO. 1

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Spring 1952

This handy reference book is made possible by the whole-hearted cooperation of many experts in their respective fields. Its objective is to interpret for the average amateur horticulturist and home gardener the research findings of the past several years in the field of chemical control of growth.

Twenty years ago even the informed amateur had never heard of PLANT HORMONES, and fifteen years ago there were still scientific men who did not believe in them; animals could have hormones, they reasoned, but not plants. I recall a conference ten years ago at the research headquarters of one of the large chemical companies that had kept itself well informed on theoretical developments in this field. One of the company's sales representatives was present and toward the end of the meeting he observed that the research developments seemed of little significance; he could not understand why the company was "monkeying with this stuff." In the ten years since that memorable remark the manufacture of synthetic plant hormones has become a multimillion-dollar business, and the salesman's company has done very well in it.

For the amateur horticulturist, gardener, orchardist, and field crop farmer, there have been just as many surprises as for the chemical salesman. Many age-old cultural methods are being set aside. Weed control in many instances has graduated from hand work to the spray rig; and the same synthetic hormone that will kill certain weeds at one concentration, will "stick" oranges on trees at another.

The right hormones, used at the right strengths and at the right times, will give such seeming paradoxes as holding flowers on trees, and making flowers fall from trees; inducing the formation of fruit without pollination, and preventing the formation of fruit entirely; more fruits, and fewer fruits (or none at all); earlier fruits, and later fruits; fruits without seeds (for eating), and fruits with more seeds (for propagation); hastening the rooting of cuttings, and preventing the sprouting of stored nursery stock and potatoes.

An important aspect of the use of plant hormones is that they are nonpoisonous to man and other animals at the strengths used.

Yours sincerely,

George Avery

Director

PLANTS & GARDENS

Kerria japonica

Vol. 8 Spring, 1952 No. 1

CONTENTS

SYNTHETIC PLANT HORMONES AND OTHER CHEMICALS USED TO CONTROL GROWTH

Use of Hormones in Gardening and Horticulture

Cover—Poison-ivy before and three weeks after being sprayed with ester of 2,4-D.
Courtesy Dow Chemical Company.

Page
Hormone Primer .... George S. Avery, Jr. 4

USES OF HORMONES

In Ornamental Horticulture

Prolonging Bloom—Oriental Cherries .. Paul C. Marth and Horace V. Wester 7
Holding Foliage on Christmas Greens 9
Preventing Fruit on Flowering Trees—Catalpa, Honey-locust, Horse-chestnut L. C. Chadwick, R. R. Miller, and Donald Erskine 10
Rooting of Cuttings .... George S. Avery, Jr. 14
Producing Berries on Female Holly Trees, Without Nearby Male Trees 16

In Prevention of Sprouting

Nursery Stock 17
Potatoes 17

In Fruit Growing

Earlier Tomatoes in Temperate Climates .... Freeman S. Howlett 18
Seedless Tomatoes in Garden or Greenhouse .... Freeman S. Howlett 18
Effect of Hormones on Tomatoes in Different Parts of the Country 20
Seedless Figs, Earlier Figs, Smyrna Figs without Pollination .. Julian C. Crane 21

Control of Preharvest Drop

Apples, Pears ... George S. Avery, Jr. 26
Oranges, Grapefruit ... William S. Stewart 29
Increased Yield—Pineapples ... Johannes van Overbeek 34
Ripening of Bananas and Apples Picked Green ... 28
Coloring of Apples on the Tree ... George S. Avery, Jr. 26
Thinning of Apples ... George S. Avery, Jr. 27

In Induction of Flowering

Pineapple (direct) ... Johannes van Overbeek 32
Litchi (indirect) ... Johannes van Overbeeek 34

In Plant Breeding

Lilies, Beans, Melons ... S. L. Emsweller 35

In Weed Control

Chemicals for Weed Control ... Louis G. Nickell 40
Maleic Hydrazide (MH) ... 48
Caution in Use of Weed Killers ... 41
Lawn Weeds—Plantain, Dandelion, Crab Grass ... Ralph E. Engel and Gilbert H. Ahlgren 42
Plants That Affect Health: Poison Ivy and Poison Sumac; Ragweed, Hay-fever Producer ... A. E. Hitchcock 46

Weeds in Crops

Strawberries ... L. L. Danielson 51
Ornamentals, Small Fruits, and Asparagus—Crag Herbicide 1 ... L. J. King 49
Potatoes ... 52
Brush—Dormant Spraying ... W. R. Mullison 53
Water Weeds ... P. W. Zimmerman 56
Wild Garlic, in Lawns and Pastures ... 50
Johnson Grass, on Ditch Banks ... 52
Mesquite, on Ranges ... 55
454 Weeds and How to Control Them ... Louis G. Nickell 58
Trade Names of Synthetic Hormones and Other Similar Chemicals, and their Manufacturers ... George A. Vradenburg, Jr. 101

Within the Brooklyn Botanic Garden ... 112

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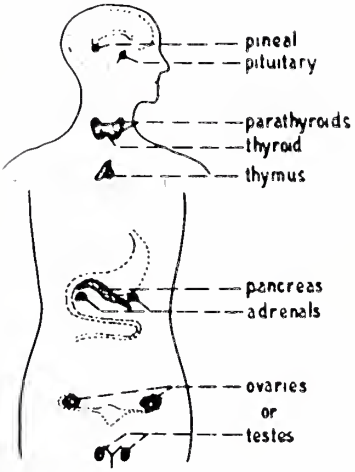
HORMONE PRIMER

What hormones are and what they do naturally; what led to the presen wide horticultural use of natural and artificial plant hormones

George S. Avery, Jr.

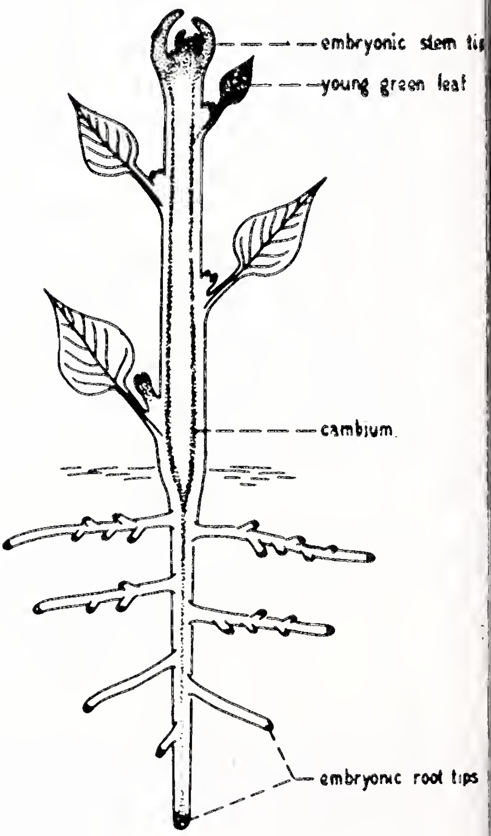
Animals

ALMOST everyone knows about hormones in animals, particularly in man, and knows that these substances are produced in ductless glands which are located in various parts of the body. The hormones secreted by such glands are circulated throughout the body by th blood stream, and were therefore long ag commonly called “chemical messengers.’ They are chemical compounds that con trol growth, sex impulses, rate of metabo lism (rate at which living processes g on), etc. The most remarkable thing abou them is that unbelievably low concentra



Where natural hormones are produced: *above*, in the human body, in the glands indicated; *at right*, in the young growing parts of plants.

Author drawings



ions of these chemical substances can do he job; it takes ever so little to achieve ver so much.

Plants

Not so well known is the fact that lants also produce hormones in their iving tissues, especially in their so-called *mbryonic* tissues—where cells are dividng and new protoplasm is being made; this means in the growing tips of branches (buds), in young leaves, in the root tips, nd in the cambium layer—the very thin layer of embryonic cells that lies between the bark and the wood, and is responsible, e.g., for the growth of a tree in diameter. Because plants are so different from animals in structure and growth, the hormones in plants cannot regulate growth in the same ways that animal hormones do. Plants have no ductless glands and no blood stream, and sex in flowers is wholly different from that in animals; yet plant hormones do travel from one part of the plant to another and produce effects in parts remote from their place of origin.

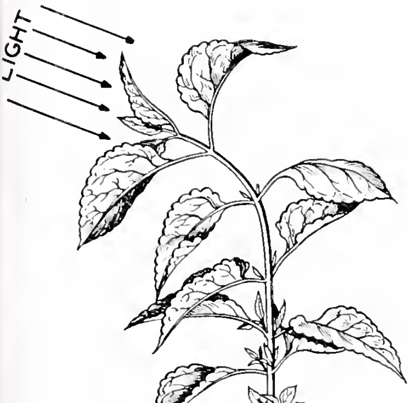
The commonest roles of hormones in the normal life of a plant are shown in the accompanying diagrams. The discovery of these facts led to the later discovery and manufacture of numerous *synthetic* hormones.

Explanations

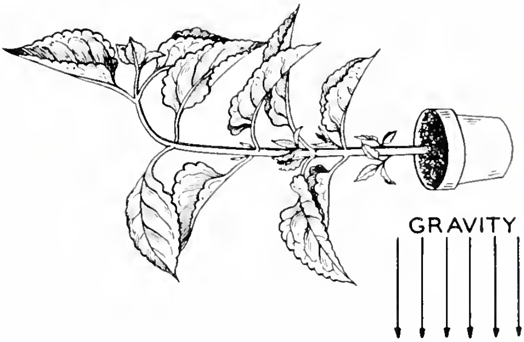
Names. Auxin, phytohormone, growth regulator, growth substance, etc., are names commonly given to plant hormones.

Naturally occurring plant hormones are special chemical substances normally produced in living plants (in very small amounts); these substances move through the tissues and control growth responses to light and gravity, as well as other living processes.

Synthetic plant hormones are chemical substances manufactured in the laboratory; they may be chemically quite different from the naturally occurring hormones but have the same general effect on growth when applied to living plants. If applied as a spray to the foliage, they enter the tissues quickly and move about



Hormones and light. A plant lighted from one side, as from a window, accumulates more hormones on the darkened side of the stem. This speeds growth on the darkened side, and the growing part of the stem "bends" toward the light.



Hormones and gravity. A plant laid on its side, even in the dark, accumulates more hormones on the underside of the stem. Hence the part of the stem that is growing "bends" upward.

through the plant like the naturally occurring hormones.

Applied to plants in low concentrations, they may hasten growth or affect it in a helpful way; in higher concentrations, some synthetic hormones are harmful to certain plants. None are poisonous to animals in the strengths used for regulating plant growth.

Herbicides are any chemicals used to kill weeds. Some of these are *selective,* that is they kill certain plants and not others. The selective herbicides are generally synthetic hormones, used at somewhat higher concentrations than would affect growth favorably. They move through the tissues of the entire plant and therefore kill roots as well as stems and leaves.

The well-known weed killer **Ammate** moves through plant tissues under certain conditions, but it is effective only in extremely high concentrations, is nonselective, and is in no sense a hormone; at the usual strengths employed, it kills all vegetation that it touches.

There are other herbicides (not hormones) that kill stem and leaves upon contact but do not move through the tissues of the plant; and so the roots remain alive and will later send up new stems and leaves.

Certain herbicides kill germinating weed seeds if applied to the soil at critical times; some of these are synthetic hormones.

In the past eighteen years researchers have found many practical applications of these discoveries. The most important of these applications are dealt with in this issue of PLANTS & GARDENS.

For Detailed Information

HORMONES AND HORTICULTURE, by George S. Avery, Jr., E. B. Johnson, R. M. Addoms, and B. F. Thomson. Published by McGraw-Hill Book Co., New York, 1947. 326 pp. $5.

The most complete book on the subject of plant hormones and other special chemicals that can control plant growth. The present issue of PLANTS & GARDENS supplements it on the more recent discoveries.

VARIOUS USES OF THE HORMONE 2,4-D

Preharvest Drop:

sprayed on citrus trees, will prevent preharvest drop of oranges and grapefruit

↑

at concentrations of 0.0004% to 0.0008%, or 4 to 8 parts per million

Fruit Ripening:

applied to green bananas and apples, will hasten ripening of fruit

↑

at concentration of 0.1%, or 1000 parts per million

The synthetic hormone 2,4-D
(2,4-dichlorophenoxyacetic acid)

at concentration of 0.001%, or 10 p.p.m.

↓

Preharvest Drop:

sprayed on WINESAP apple trees, will prevent preharvest drop of apples

at concentrations of 0.1% to 1%, or 1000 to 10,000 p.p.m.

↓

Selective Weed Killing: will destroy many weeds in lawns, yet not kill grasses. Similarly, will destroy weeds in certain crops, yet not damage the crop plants.

Roche

Double-flowered Japanese cherry tree. Hormone spray applied just as blossoms open will prolong blooming period several days.

LONGER LIFE FOR CHERRY BLOSSOMS

How to use hormone sprays to delay petal fall in oriental flowering cherries

Paul C. Marth and Horace V. Wester

IN the spring, one of the principal attractions for visitors to Washington, D. C., is the mass display of oriental cherry blossoms around the Tidal Basin and Haines Point. Hundreds of trees of the single YOSHINO variety and some of the AKEBONO variety (*Prunus yedoensis*) line the Tidal Basin, while at present the extensive plantings around Haines Point consist principally of KWANZAN, SHIRO-FUGEN, and other double varieties of *P. serrulata*. The double varieties have also been used very effectively in street plantings, in parks, and around private homes in Washington and other cities.[1]

A characteristic of oriental flowering cherries is that the open flowers withstand a considerable amount of cold without apparent damage. The trees in Washington have been known to experience storms of snow, sleet, and ice at flowering time without serious interference with their subsequent floral display when the

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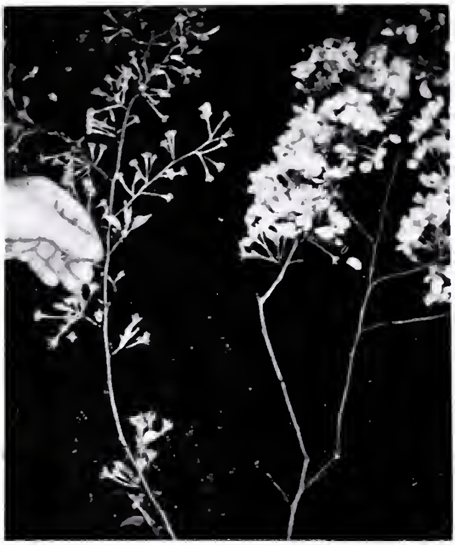
[1] The famous Cherry Walk at the Brooklyn Botanic Garden is well known to many.



Courtesy U.S. Dep't. of Agriculture

Petals have fallen from the branch of single-flowered Japanese cherry **at left;** it was not sprayed.

Branch at right, from adjacent tree, was **sprayed** with hormone solution when in full bloom. Both photos five days after full bloom.

temperature rose. Unseasonable warm weather in the spring, on the other hand, causes the flowers to open rapidly; and when it persists they tend to shed rather quickly.

Synthetic hormone sprays have helped retard petal fall of both the single and the double-flowered varieties of oriental cherry. High lights from experiments conducted in the national capital are presented here.[2]

Preparation of the Spray

The sprays that have proved most effective in retarding petal fall of oriental cherry are the same as those recommended for preventing preharvest drop of apples. Commercial preparations ready for dilution with water in the spray tank are available at most hardware, seed, or garden supply stores. These preparations are sold under a variety of trade names such as App-L-Set, Apple-Lok, Fruit Fix, Fruitone, Parmone, and Stop-Drop. The active ingredient in these preparations is the synthetic hormone **naphthaleneacetic acid,** or one of its chemical forms, or **naphthaleneacetamide.** Instructions are given on the package regarding the quantity of the product to add to water, to give the so-called standard strength of spray (10 parts per million). This concentration was found to be the most desirable to apply to flowers of oriental flowering cherry. No harm ensued from doubling the spray strength, but tripling the dosage resulted in deformation of the young leaves.

Warning

Applications of the 2, 4-D (phenoxy) type of synthetic hormone to cherry flowers for the purpose of retarding petal fall is not recommended at present. Preliminary tests with these materials indicate that at least some of the *phenoxy* compounds will cause malformation of young developing cherry leaves even though the petals may respond favorably to the treatment. This precautionary note is inserted because fruit growers now use 2,4-D compounds to retard preharvest drop of certain fruits, and trade-name products that contain them are being sold for that purpose. Amateur horticulturists and gardeners should read the ingredients on the label before using any of these products on oriental flowering cherry trees and should be sure they are using the **naphthalene,** rather than the phenoxy (2,4-D), compounds.

Time and Method of Application

For best results the sprays should be applied to the tree and flowers at the time a majority of the flowers are fully open. Sprays applied when the flower buds were just beginning to open have not been found effective in retarding petal fall. Late spray applications, a few days after full bloom, likewise have been without effect.

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[2] These experiments were carried on jointly by the National Capital Parks, Department of the Interior, and the Bureau of Plant Industry, Soils, and Agricultural Engineering, Department of Agriculture. A full account of them was published in *Science*, vol. 111, p. 611, 1950.

In preliminary experiments, small nd atomizers were used successfully in plying the sprays to the flowers on nall branches. Later, hand pressure rayers proved useful in treating anches and small trees. For large-scale raying tests, power equipment common- used for applying insecticidal and fun- cidal sprays were used at slightly re- ced nozzle pressure to avoid excessive ysical knocking off of the petals.

Effectiveness of Spray

The greatest benefit from the use of nthetic hormone sprays in retarding etal drop of oriental flowering cherries as obtained when the temperatures were ther high at blossoming time.

In determining whether to use the prays on cherry flowers, it may be well consult weather reports as close as pos- ible to the estimated full bloom period. f temperatures ranging well above 70°F. re predicted, it would appear desirable o spray. Prolonged cool weather at blos- oming time, on the other hand, tends to rolong the normal life of the petals; and praying under these conditions may not e advantageous.

In some small-scale tests, sprayed trees f the single-flowered YOSHINO variety ave retained as many as 25 per cent of heir petals four to ten days longer than he unsprayed trees. The flowers of this hite variety develop a pink coloration as hey remain on the tree. They are fresh in ppearance until they drop off.

The double-flowered KWANZAN variety has proved even more responsive to the sprays. In a typical experiment 23 per cent of the sprayed flowers of this variety remained attached for thirteen days after full bloom, while only 4 per cent remained on the unsprayed branches. The double-flowered varieties have long slender flower stalks, and the flower heads tend to become bruised and discolored by whipping back and forth under windy conditions. Even though the treated flowers are thus injured after a prolonged period on the tree, they present a fairly attractive mass floral display when viewed at a distance of 10 to 15 feet.

Response of Other Ornamental Trees and Shrubs

The bracts of white flowering dogwood have shown a definitely favorable response to the synthetic hormone sprays; *p*-Chlorophenoxyacetic acid appeared to offer more promise than naphthaleneacetic acid. The former compound, however, tended to deform the young dogwood foliage even when applied at concentrations as low as 5 parts per million, and for this reason it may not prove desirable.

Flowers of a number of other ornamental plants were tested along with ornamental cherry and dogwood but did not respond markedly. These included azalea, chokeberry (*Aronia*), American and Asiatic crab apples, flowering almond, flowering quince, redbud, bridal wreath spirea, lilac, and star and saucer magnolias.

KEEPING LEAVES ON CHRISTMAS GREENS

Shippers of Christmas greens (especially holly) are often troubled by the dropping of leaves from the branches in transit. This dropping is especially likely to occur if the holly is shipped slightly damp, though moisture preserves the glossy greenness of the leaves. Dipping the freshly cut branches in 0.001 to 0.003 per cent water solution of naphthaleneacetic acid before packing for shipment greatly reduces the shedding of the leaves. This is the same synthetic hormone used for control of preharvest drop of apples, and is marketed under several trade names (see p. 101). For stopping leaf fall of holly these products should be used at approximately double the strength recommended for preventing fruit drop. American holly (*Ilex opaca*) responds as well to the treatment as does the English holly (*I. aquifolium*); but Euonymus, live oak, and eastern white pine do not.

PREVENTION OF UNDESIRABLE FRUIT ON FLOWERING TREES

How to make certain kinds of flowering trees more desirable by eliminating their fruits without injury to their leaves

L. C. Chadwick, R. R. Miller and Donald Erskine

Pods of honey-locust in August and September spoil the appearance of an otherwise handsome tree.

Brownell photos

MANY of our ornamental trees have fruits that are objectionable because of their unsightliness on the tree, the litter created on the ground, or a disagreeable odor during decomposition on the ground. If the development of such fruits could be prevented, the ornamental value of the trees would be greatly enhanced.*

The Problem

Orchardists have used sprays to thin apples for a number of years, but the elimination of fruits on ornamental trees presents problems not confronting the orchardist. On ornamental trees, it is necessary to have complete or nearly complete elimination of fruit setting without injury to the foliage; while on fruit trees, partial reduction of fruits is satisfactory even with some foliage injury.

Experiments

The results of a three-year study, using some twenty-five spray materials and over 1,000 different spray applications, are shown in the accompanying chart. During the first two years, applications were made on individual branches with the aid of a 3-gallon knapsack sprayer. In 1950 in some cases, a power sprayer was used to spray whole trees with the exception of a few branches left as check areas.

Only the chemical materials found to be successful or promising in the elimination of fruits are mentioned, and these are given in connection with the results obtained with the different plants.

The kinds of trees that were tested fall into three groups, as far as the effectiveness of the spray materials in eliminating fruits is concerned: (1) results satisfac-

---

*Some kinds of flowering trees are naturally sterile, i.e., they do not bear fruit; but these are not the ones under consideration here.—ED.

ormone spray applied when the tree is in **full bloom** will prevent formation of pods.

ry; (2) results partially satisfactory
nd promising; (3) results unsatisfactory.

From these results, it is clear that vari-
us sprays, applied as described here,
ill eliminate or greatly reduce fruit set-
ng, retard fruit development, or cause
e dropping of young fruits of several
inds of flowering trees without causing
ny apparent damage to the health of the
ree.

Flowers With Leaves

To prevent fruit setting on most of the
rees that have leaves at the time of full
loom, the most satisfactory of the com-
ounds tested appear to be naphthalene-
cetic acid and related synthetic hor-
nones, sold under such trade names as
App-L-Set or Parmone. Trees in this
ategory include horse-chestnut (*Aescu-
us hippocastanum*), tree-of-heaven (*Ai-
anthus altissima*), western catalpa (*Ca-
alpa speciosa*), thornless honey-locust
(*Gleditsia triacanthos inermis*), and possi-
ly purple crab apple (*Malus purpurea*).

Exceptions to this observation are Nor-
way maple (*Acer platanoides*), certain
specimens of purple crab apple, and
naidenhair-tree (*Ginkgo biloba*). Sprays
of naphthylphthalamic acid applied to Norway maple and purple crab apple were more successful in eliminating the setting of fruits than naphthaleneacetic acid or related commercial compounds.* Maleic hydrazide has been successful in eliminating fruit setting on maidenhair-tree.

Flowers Before Leaves

To prevent fruit setting on such trees as European ash (*Fraxinus excelsior*), Kentucky coffee-tree (*Gymnocladus dioica*), and Carolina poplar (*Populus canadensis*), the dinitro sprays such as Elgetol, Di-Nitrol, DN 1, DN 111, and DN 289, can be used successfully. Bloom occurs on these trees previous to the development of foliage in the spring.

Thus it appears that we no longer need rely so heavily on the sterile varieties of flowering trees for ornamental plantings; hormone sprays such as App-L-Set and Parmone now provide us with a sure method of eliminating many kinds of unwanted fruits.

---

*Although in some cases it is desirable to eliminate the fruit, it should be kept in mind that much of the value of certain kinds of crab apples is the bright-colored fruit in the fall and the attraction of birds during the winter.

Results of Various Sprays Used to Prevent Fruit Formation

1. Results Satisfactory

Name of Plant	*Material Used*	*Concentration*	*When Applied*	*Effect on Fruit*	*Effect on Foliage*	*Remarks*
western catalpa (*Catalpa speciosa*)	App-L-Set	2½ lbs. per 100 gal.	full bloom	complete elimination	none	Spray did not affect bloom
	Parmone	13¼ fl. oz. per 100 gal.				
	A-Naphthalene-acetic acid	1-1/3 oz. per 100 gal.				
European ash (*Fraxinus excelsior*)	DN 289	1 qt. per 100 gal.	flower cluster 2½ to 3 inches long	complete elimination	none	1950 application, April 28, resulted in slight burning of tips of first leaves
horse-chestnut (*Aesculus hippocastanum*)	App-L-Set	2½ lbs. per 100 gal.	full bloom or fruit ⅜ inch in diameter	complete elimination	none	Extends bloom one week; grays flowers slightly
	N-1-naphthyl-phthalamic acid	5.4 oz. per 100 gal.	fruits about ⅜ inch in diameter	complete elimination	none	Must not be applied at full bloom, as it will cause injury to leaves
	Parmone	13¼ fl. oz. per 100 gal.				
thornless honey-locust (*Gleditsia triacanthos inermis*)	A-Naphthalene-acetic acid	1-1/3 oz. per 100 gal.	full bloom or fruits 1 to 2 inches long	elimination or dropping of young pods	none	
	App-L-Set	2½ lbs. per 100 gal.	fruits 1 to 2 inches long	complete removal	none	No results when applied at full bloom
Carolina poplar (*Populus canadensis*)	DN 1	6 lbs. DN-1 and 1 pt. summer oil per 100 gal.	full bloom	complete elimination	none	
	DN 289	1 qt. DN 289 and 1 pt. summer oil per 100 gal.				
	Elgetol	2 qts. per 100 gal.				

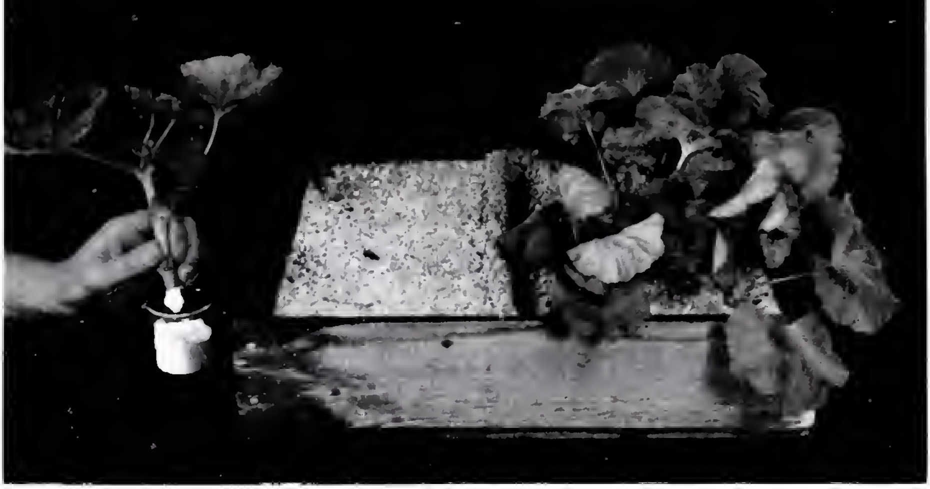
2. Results Partially Satisfactory and Promising

Norway maple (*Acer platanoides*)	Naphthyl-phthalamic acid	600 ppm. or 1-1600	full bloom	nearly complete elimination	moderate twisting	App-L-Set or Dinitro strong enough to reduce fruit deforms leaves
tree-of-heaven (*Ailanthus altissima*)	App-L-Set	5 lbs. per 100 gal.	full bloom	85% to 90% elimination	none	Most of fruit which did set dropped by mid-August
	Parmone	26.4 oz. per 100 gal.				
maidenhair-tree (*Ginkgo biloba*)	Maleic hydrazide	750 ppm. or 1-1300	full bloom	nearly complete elimination	slight reduction in size	When applied to fruit 3/16" in diameter, fruit was greatly reduced in number and size with no injury to the foliage
Kentucky coffee-tree (*Gymnocladus dioica*)	Elgetol	2 qts. per 100 gal.	small developing fruits	50% reduction	slight	
	DN 111	2½ lbs. per 100 gal.				
	Di-Nitrol	1½ lbs. per 100 gal.	small developing fruits	60-70% reduction		
purple crab apple (*Malus purpurea*)	N-1-Naphthyl-phthalamic acid plus Dowax	5.4 oz. per 100 gal. 1-20	prepink stage	complete elimination	none	
	Parmone	7 oz. per 100 gal.	small developing fruits	complete elimination	none	Branches on test trees fruited only slightly

Santomerse S (Monsanto Chemical Co.) was used as a sticker-spreader, except where summer oil was used, at the rate of 1 pint per 100 gallons of water in all solutions.

3. Results Unsatisfactory

white mulberry (*Morus alba*)
American sweet gum (*Liquidambar styraciflua*)



Method of treating cuttings with hormone rooting preparation. Cuttings dipped in hormone powder (and excess shaken off) before being placed in moist sand rooting medium.

ROOTING OF CUTTINGS

How to get faster and better rooting by the use of hormones. A few general suggestions as to kinds of plants and methods of procedure

George S. Avery, Jr.

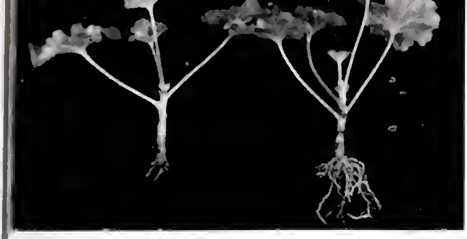
EVERYONE likes to be given a few slips (or cuttings) of coveted plants in his neighbor's house or garden; and having received them, likes to see them root promptly and grow into sturdy plants. Plants successfully grown from cuttings attain good size in a minimum of time and can be depended on to have all the characteristics of the plant from which the slips were taken.

On the other hand, plants raised from seeds collected from desirable horticultural varieties are usually disappointing in that they fail to show the best features of the parent plant; or as it is commonly expressed, many plants fail to come true from seed. Plant a pit from a delicious peach, for example, give it generous garden space and the best of care—and it will be a mongrel every time. Moving a young apple tree into the garden from the wild will be equally disappointing—and so will collecting and planting seeds from choice varieties of ornamental plants. Even when they come true, seedlings take much longer to mature than plants from cuttings.

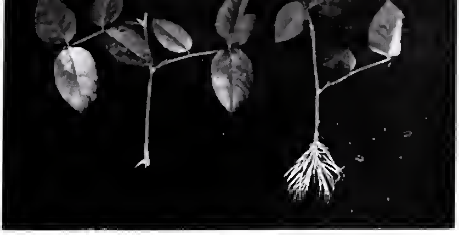
Hormones

Cuttings of some kinds of plants naturally root much more readily than others, and some will not root at all. Synthetic hormones are a great aid to rooting; but let there be no illusions as to what hormones will and will not do. They will **not** cause roots to form on cuttings of varieties that will not root at all without hormone treatment; they will **not** substitute for skill or good care in raising plants. They **will hasten** rooting and cause **more** roots to form on cuttings that would root anyway.

Commercial synthetic hormone preparations for the rooting of cuttings are of two kinds: indolebutyric acid (Hormodin, for example) and naphthaleneacetic acid and chemically related compounds (Rootone, for example). Both of these preparations are available in different strengths, because cuttings of some varie-



Geranium cuttings of the same age. *Left*, not treated. *Right*, treated with hormone.



Photos courtesy Boyce Thompson Institute

Cuttings of rose BRIARCLIFF planted three weeks previously. *Left*, not treated. *Right*, dipped in rooting powder.

ties require a greater chemical stimulus than others, for satisfactory rooting.

Suggested Plants

Here are a few examples of common garden plants and house plants that root easily. Most of them will root satisfactorily without hormones but will root faster and better with hormone treatment; the lowest strength should be used for them.

African-violet
Ageratum
Begonia
Carnation
Chrysanthemum
Coleus
Crassula
Dahlia
Fuchsia
Geranium
Lavender
Petunia
Phlox
Sage
Snapdragon
Verbena

Certain shrubs also root easily, if cuttings are taken at the critical time; but hormones will be a greater help in this group than in the previous one.

Barberry
Bayberry
Butterfly-bush
Crape-myrtle
Euonymus
Forsythia
Hydrangea
Lantana
Mock-orange
Photinia
Rose
Spiraea
Stewartia
Weigela

Here are a few shrubs, vines, and small trees that either root with greater difficulty, or simply require a greater concentration of hormone for best effect.

Arbor-vitae
Beauty-bush
Boxwood
Clematis
Cotoneaster
Flowering quince
Heath
Heather
Holly
Juniper
Lilac
Pachysandra
Silver-bell
Yew

Other Lists

Manufacturers' directions give lists of plants for which different strengths of the preparations are recommended. They also include directions for making cuttings. Information on cuttings is also given in PLANTS & GARDENS: 1947, p. 89 (perennials); 1948, p. 108 (summer cuttings); 1949, p. 10 (chrysanthemums), p. 13 (rhododendrons and azaleas), p. 169 (dwarf conifers), p. 238 (hardwood cuttings); 1951, p. 98 (woody plants).

More information on trials of hormones on the rooting of cuttings, with a longer list of plants, may be found in the 100-page chapter on rooting of cuttings in "Hormones and Horticulture"; and another long list in Publication No. 1 of the Maria Moors Cabot Foundation (K. V. Thimann and J. Behnke), obtainable from the Harvard Forest, Petersham, Massachusetts. 1947. 272 pages. $1.

A Few Generalizations

Herbaceous plants (nonwoody), for example most house plants and summer annuals or perennials, will root at any season if they are in a good growing state. Cuttings of most evergreens should be taken in the fall, winter, or early spring—before growth has begun. Cuttings of deciduous shrubs are most likely to succeed if taken sometime between mid- or late June and mid-August (in the New York area). As a rooting medium, sand is most readily available, least expensive, and probably most satisfactory. As soon as the cuttings are well rooted, they should be transferred to good garden soil.

New Jersey Conservation Dept.

American holly.

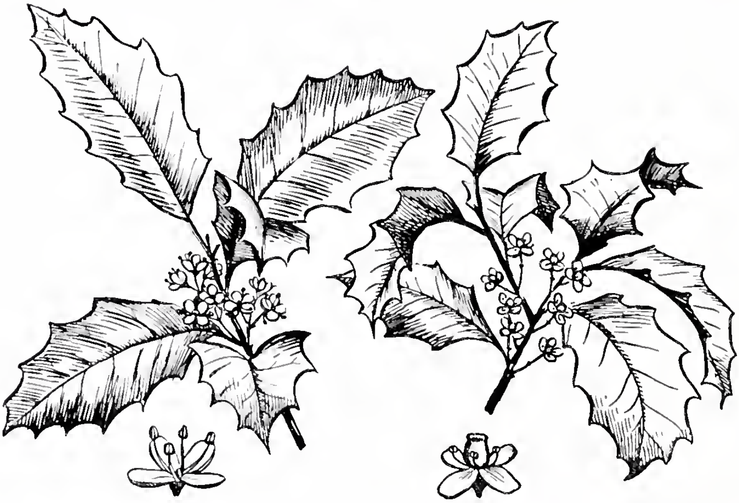
HOLLY BERRIES WITHOUT POLLINATION

Many people plant holly trees and are disappointed to find that they have no berries. Failure of holly trees to produce berries may be due to either of two causes: the trees may all be male; or they may all be female, with no male trees near.

While most plants have both sexes in the same flower, holly has separate male and female flowers, borne on separate trees. Berries are never borne on the male trees; and they are produced on the female trees (in nature) only when male trees are growing near enough for bees to carry pollen from male to female trees.

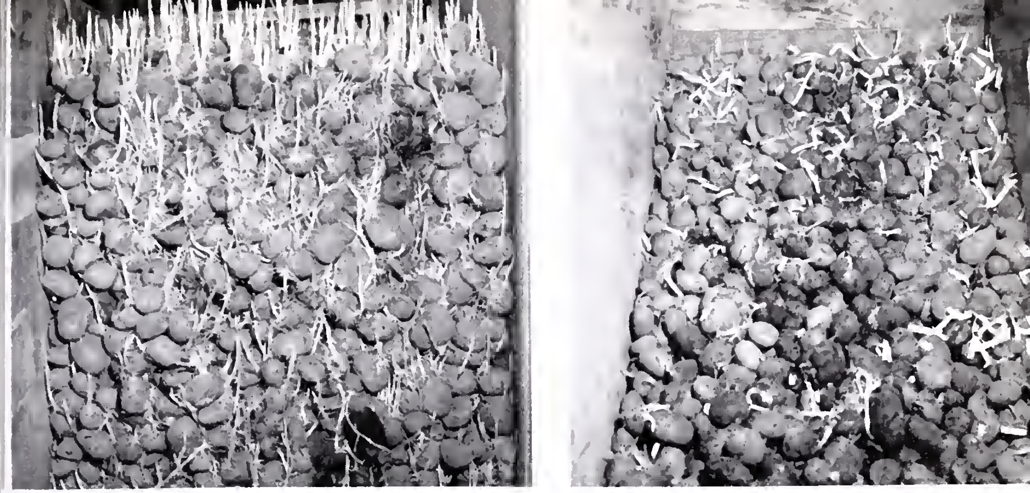
Under natural conditions, then, pollination is necessary for berry formation. But certain hormone sprays will induce female holly trees to produce berries without pollination. These same preparations produce seedless tomatoes (see p. 18 of this issue); the holly berries will be seedless, but this does not matter unless one wishes to raise holly from seed.

Holly trees that do not produce berries can be identified as male or female only when they are in flower. The accompanying drawings show the two kinds of flowers. It is useless to spray male flowers!



Maud H. Purdy

Male and female flowers (*left* and *right*) of American holly from separate trees. Male (pollen-bearing) trees never produce berries.



Courtesy Cornell University

Potatoes stored about six months. *Left,* without hormone treatment. *Right,* with strips of paper soaked in a hormone solution (white strips are paper, not sprouts).

TO RETARD SPROUTING OF STORED POTATOES

Several million bushels of potatoes are lost each year as a result of sprouting in storage. Large-scale potato users, such as potato chip manufacturers and potato dehydrators, require potatoes that have been stored at a temperature of 40°F. or slightly higher. At these temperatures potatoes generally sprout heavily after a few weeks in storage. Hence there has been demand for a chemical that would inhibit sprouting of potatoes stored at the temperatures that will best preserve their natural state.

The synthetic hormone naphthaleneacetic acid (in the form of its methyl ester) successfully inhibits the growth of sprouts. It may be sprayed or dusted on, or (perhaps best for the home gardener) it may be applied in the form of paper strips soaked in a water solution of the chemical. A handful of shredded paper or confetti, impregnated with a half ounce of the chemical and scattered through a bushel bag of potatoes, will definitely retard sprouting.

This same chemical has been found effective in retarding sprouting of beets and carrots, and yellow and white turnips. It is commercially available as Dormatone, Sprout-lok, and Potato Fix.

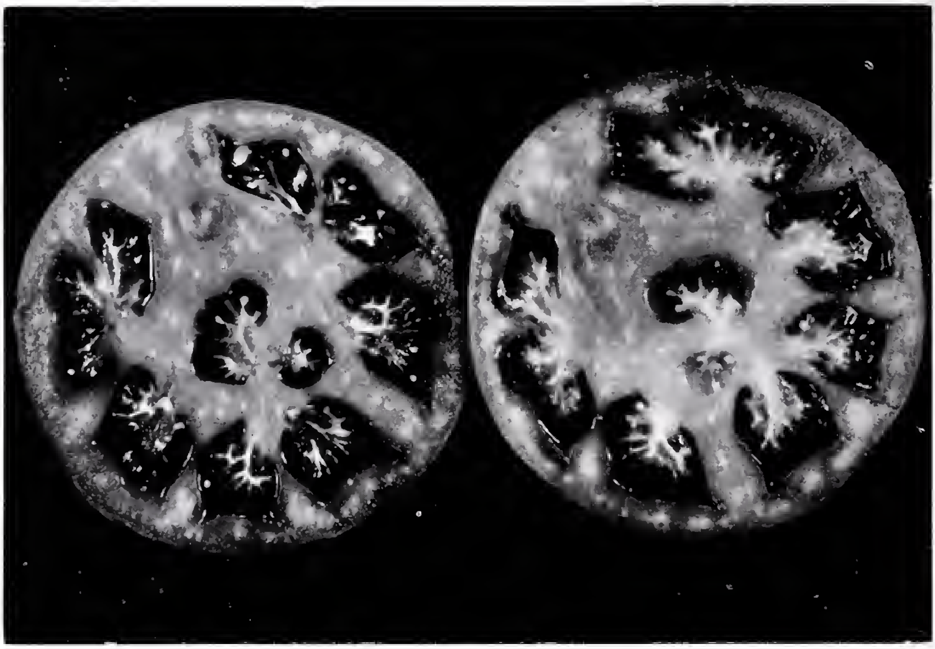
TO PREVENT SPROUTING OF STORED NURSERY STOCK

Many nurserymen store various kinds of plants for several months before shipping. Some plants naturally have a rest period long enough to last through the storage time. Others, such as roses, have a short rest period and tend to sprout in storage. The sprouts use up food reserves and weaken the plant so that it often fails to grow when set out in the garden.

In experiments at the United States Department of Agriculture Plant Industry Station, Marth has found that spraying the tops of hybrid tea rose bushes with the methyl and ethyl esters of naphthaleneacetic acid keeps them from sprouting for several months if they are treated when they are first put into storage, and while they are in a resting condition.

One-year old apple, pear, and peach trees can be prevented from sprouting by the same method.

In spite of this discovery, it appears that most nurserymen still rely on older methods to retard sprouting.



Courtesy Ohio State University

Seedless tomatoes produced in the home garden with the help of hormones.

SEEDLESS TOMATOES

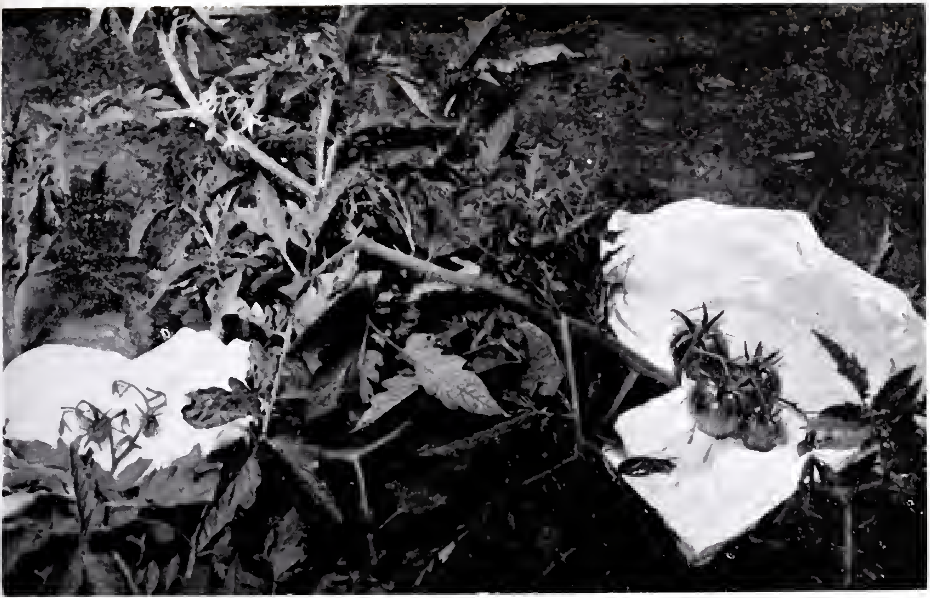
How to produce them in the home garden and at the same time to have earlier and less acid tomatoes

Freeman S. Howlett

EVER since seedless tomatoes were first produced, they have intrigued the amateur as well as the professional grower. There is no reason why the home gardener should not buy one of the hormone preparations now on the market and test for himself the advantage or disadvantage of "treated" tomatoes. If he and his family prefer a milder and less acid fruit, and if he wants his tomatoes to be the earliest in the neighborhood, then he should experiment with chemical treatment.

Real Cause of Seedlessness

Fundamentally, seedlessness resulting from treatment is more or less of a byproduct: the real advantage of the treatment is the stimulating effect upon the development of the young fruit. Normal seed development naturally has this stimulating effect on what is called the *fruit setting;* but often, when conditions are unfavorable early in the season, seed development does **not** take place and thus the stimulating effect necessary for fruit setting is lacking. Frequently plants re-



Dow photo (S. H. Wittwer) of tests at Michigan State College

Effect of hormone spray on early tomato production (from first flower cluster). *Left*, cluster from flowers not sprayed. *Right*, cluster from flowers sprayed with Sure-Set.

ceiving the best of care set fruit poorly or not at all on the first flower cluster.

This, then, is where the synthetic hormones, or chemical "treatments" become important: they take over the normal function of the seeds in stimulating fruit development. Interestingly enough, these hormones do not stimulate seed development: indeed, they tend to repress it. Thus the early, artificially stimulated fruits are relatively seedless; but the hormones are much more valuable for the stimulation of fruit development early in the season than for causing seedlessness.

As the season progresses, tomato fruits may develop rapidly without treatment. If treatment is continued under these circumstances, it may produce some seedlessness, though not to the degree observed earlier, when normal seed development was retarded by weather conditions.

This, then, is about what may be expected from treating garden tomatoes: a rapid start in cold weather, and a less acid fruit in which there will still be the tiny seed coats but few or no seeds. The method of treatment is not complicated or particularly arduous.

Chemicals

The home gardener will find it simplest to purchase one of the trade compounds. Sure-Set, for instance, contains one of the chemicals found to be particularly effective.

For the scientific investigator the choice of chemical compounds is a trying problem. He must choose among indolebutyric acid, betanaphthoxyacetic acid, parachlorophenoxyacetic acid, and others. Different compounds produce various effects upon the quality of the fruits, even upon the size and shape. For instance: naphthaleneacetic acid may be used but is generally found to be less effective; betanaphthoxyacetic acid is quite satisfactory; and parachlorophenoxyacetic is more likely to continue to produce seedlessness as the season advances and this effect normally becomes less likely.

Courtesy Ohio State University

Spraying tomato flowers with a hand sprayer to produce seedless fruit.

Application

The liquid compound is placed in a small ordinary household atomizer. As soon as the tomato flower reaches full bloom, and the pistil (in the center) is exposed full-length to the bulbous base, the chemical compound is sprayed on the flower. One such treatment is sufficient for a flower; but as the flowers continue to open, repeated applications must be made. This, however, will not require constant attention. Treatments are generally required at intervals of about a week, depending on the weather; the warmer the weather, the more frequently treatment is required. No additional attention need be given; but if the plants are dry, the growth of fruits will be restricted.

Now you may mystify your neighbor with a present of seedless tomatoes, until he also buys an atomizer and produces equally mysterious results in his own garden.

HORMONES AND TOMATOES IN DIFFERENT AREAS

New York: Plants sprayed with Sure-Set produced 100 per cent more tomatoes in early plantings.

Ohio: Plants of some varieties treated with Sure-Set produced more tomatoes than untreated plants in first pickings but lagged behind in later pickings; other varieties produced more and larger fruits throughout the season, although only the first three flower clusters were treated.

Texas: 100 acres of plants sprayed with Sure-Set produced 5500 pounds of tomatoes in the first two pickings; a comparable control plot (unsprayed) produced only 2500 pounds.

Utah: Even though night temperatures often fell below 50°F., plants sprayed with Sure-Set produced 50 per cent more fruit—often seedless.

It appears that Sure-Set will produce more early tomatoes in areas where the night temperatures fall below the most favorable range for fruit setting, namely 59° to 68°F.

FIGS AND HORMONES

Earlier figs, seedless figs, Smyrna figs without pollination

Julian C. Crane

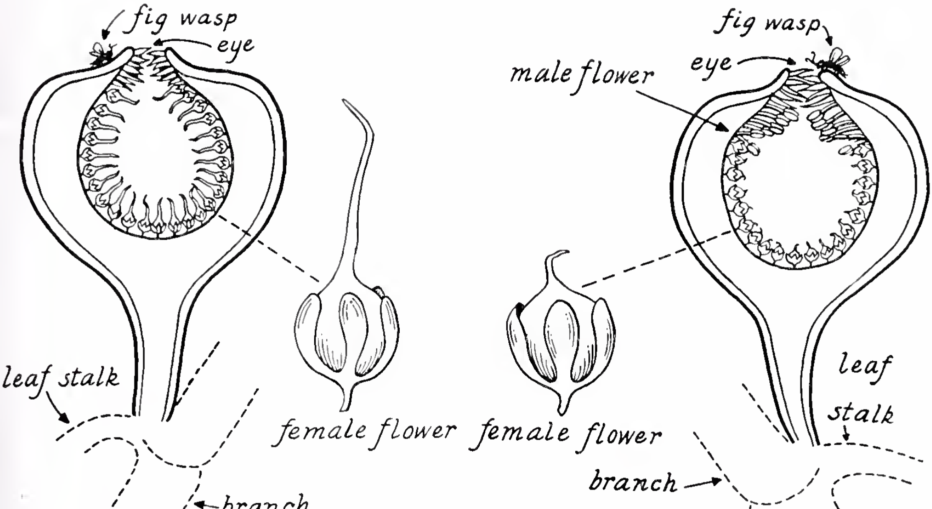
THE CALIMYRNA fig business in California occupies a unique position among the fruit industries of the world. It is the only deciduous-tree fruit industry in which it has been shown to be commercially practical to apply a plant hormone to induce fruiting instead of allowing the fruit to form in the natural way, by pollination.

Earlier Fruit

Those who grow figs where the season is not long enough to mature the fruits properly will be interested in another hormone, which hastens the growth of the fruits, although its use is not yet commercially feasible.

A practice as old as history itself is the application of a drop of olive oil to the "eye" of the fig (labeled in the drawings at the bottom of this page) to hasten ripening. If applied at exactly the right time (after the interior of the fruit has changed from light green to pink or red) mature figs may be had from one to two weeks earlier than usual.

Now a hormone has been found, which hastens the growth to such an extent that maturity may be obtained as much as two months before the normal time. **Inject-**



Figs in the flowering stage—diagrams of lengthwise slices. *Left*, edible fig—flowers all female. *Right*, caprifig, with male and female flowers. Under natural conditions, fig wasp must carry pollen from caprifig to Smyrna type of edible figs.

Courtesy University of Californi

The hormone spray Fig Fix being applied to CALIMYRNA fig trees as a substitute fo cross-pollination by the fig wasp.

ing the solution through the eye and into the cavity of the fig has the advantage of bringing early fruit maturity without injury to the foliage, but this procedure is impractical commercially. When the solution is **sprayed** on the figs, there have always been varying degrees of foliage injury, but the fruit invariably matures about fifteen days following application. The later in the season the spray is applied, the better is the quality of the fruit stimulated to mature early. The solution is 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) at a concentration of 25 to 50 parts per million parts of water.

Caprification

The production of CALIMYRNA (Smyrna) figs is a highly technical and specialized industry that exhibits the interdependence of plant, insect, and man. A brief account of the involved procedure for pollination of this ancient fruit will bear out this point.

The edible fig fruit is a fleshy, hollow structure, the inner wall of which, when immature, is lined with female flowers; at maturity this wall is lined with numerous tiny hard dry structures popularly regarded as "seeds," but actually little dry fruitlets (technically known as *achenes*) each containing one seed. At the tip o the fig is an opening from the hollow interior to the outside. This opening, commonly called the "eye," is covered by series of tiny overlapping leaflike structures.

In respect to their pollination requirements, edible figs are of two main type The flowers of the common type do no require pollination for the fig to develo to maturity. Numerous varieties of thi type are grown in the South Atlantic an Gulf States, as well as in California.* Figs of the Smyrna type, of which th CALIMYRNA variety (produced only i California) is a typical example, gro and mature only after the pollination o their flowers and the resultant development of seeds. The source of pollen i this case is the inedible male fig, or caprifig, which grows on separate trees. Caprifigs contain both male and female flowers the latter, because of their short styles provide a suitable place for the fig was (*Blastophaga psenes*) to lay its eggs. Th fertilized adult females leave the interio of the caprifig by crawling through th

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*And even as far north as Long Island —ED.

Courtesy R. M. Warner, California Fig Institute

Twelve thousand acres of CALIMYRNA figs grace the San Joaquin Valley of California.

'eye" and fly to a young fig of the suceeding crop, where they lay a single egg n each female flower. Three generations f this tiny wasp occur each year, a single eneration passing its life cycle in each f the three crops of caprifigs produced nnually by the caprifig tree.

One of the oddities of nature is the act that the wasps fly out of the summer rop of caprifigs in search of a place to ay their eggs, at the same time at which the flowers in the young Smyrna figs are ready for pollination. Man modifies the normal course of events by picking the caprifigs (with their wasps) and suspending them in the Smyrna trees at periodic intervals during a two- to three-week period; (the caprifigs are placed in perforated paper bags or wire baskets, or hung on wires.) Hence, the wasps, which become dusted with pollen when leaving the caprifig, enter Smyrna figs instead of caprifigs. The wasps, which generally lose their wings as they push their way through the "eye," walk over the mass of long-styled flowers in a vain attempt to deposit their eggs; but they accomplish pollination involuntarily. The wasp either emerges from the fig or dies within it. The process of pollen transfer by the wasp from the caprifig to the Smyrna fig is called **caprification.**

Difficulties

Although many varieties of figs were introduced into California from Europe and the Mediterranean area during Colonial times, the demand by consumers for the unsurpassed quality of the Smyrna fig convinced California orchardists that they should obtain and produce this type. The trials and tribulations associated with the eventual establishment of the industry in the state make a most intriguing story. Suffice it to say here, however, that the Smyrna tree was introduced from Turkey in 1880, but the successful establishment of the fig wasp in caprifig trees did not take place until twenty years later. This latter accomplishment stimulated interest in the production of this type of fig, and today there are approximately twelve thousand acres of the CALIMYRNA variety in the state.

It soon became apparent, however, that a fungus disease known as *endosepsis,* or internal rot of the fruit, might wipe out this newly established industry. The fungus develops in the fruit of the caprifig; at the time of caprification, the spores (which reproduce the fungus) are transmitted by the fig wasp to the young CALIMYRNA figs; the average caprifig contains some two hundred wasps. About a third of the total Calimyrna fig crop produced each year is not marketable, and the major part of this loss is caused by the internal rot disease spread by the fig wasp.

Other problems are associated with caprification. The grower must either maintain caprifig trees (worthless except for pollination purposes), which occupy valuable land area, or purchase caprifigs from other growers. In either case, the risk exists that the caprifigs and young Calimyrna figs will not reach the proper stage of development for pollination at exactly the same time.

Of no minor consequence is the grower's predicament when low temperatures injure or kill the overwintering caprifig crop that perpetuates the wasp population. Frequently the expensive operation of orchard heating must be relied upon to save the crop.

Hence it is little wonder that the Calimyrna fig grower looks upon caprification as a necessary evil and would welcome its elimination.

Hormones versus Pollination

A series of investigations was therefore begun in 1947 to determine whether or not the application of a synthetic plant hormone would set and mature this variety of fig and thus eliminate the necessity of using caprifigs and wasps.

Several hormones were applied in various ways at different times throughout the period during which the flowers were receptive to pollination. A spray application of indolebutyric acid to the young fruits and foliage resulted in a 71 per cent setting of fruit as compared with a 52 per cent setting for trees that were pollinated: about 20 per cent more figs were produced with a single spray application of the hormone than by the usual practice of caprification. From the standpoint of fruit setting, these results were encouraging; but when other factors were considered, the problem was far from being solved. In addition to the prohibitive cost of the material when it was used at a concentration sufficient to bring about good fruit setting, it proved toxic and burned the leaves.

One of the hormones tested during th 1948 season — para-chlorophenoxyaceti acid—was found to be very effective i promoting fruit setting without injury t fruits, foliage, or twigs. Thus a substanc had been found which made possible th elimination of the necessary evil mentioned above. Furthermore, the cost o this hormone and its application is between $5 and $6 per acre of trees, whil caprification expenses are between $2 and $35 per acre.

Experimental tests with this hormon were expanded in 1949. The results wer so promising that in 1950 a local chemica company manufactured and marketed spray material called "Fig Fix," the active ingredient of which is para-chlorophenoxyacetic acid. Total yields of frui per acre were slightly higher where Fig Fix was used than where the usual procedure of caprification was followed. Th outstanding result, however, was the difference in marketable fruit produced by the two methods. Depending upon th season and the particular orchard, from 13 to 31 per cent more marketable figs have been produced where Fig Fix has been applied than by caprification. The major portion of this increase was due to the fact that the internal rot disease was nonexistent in the hormone-produced figs.

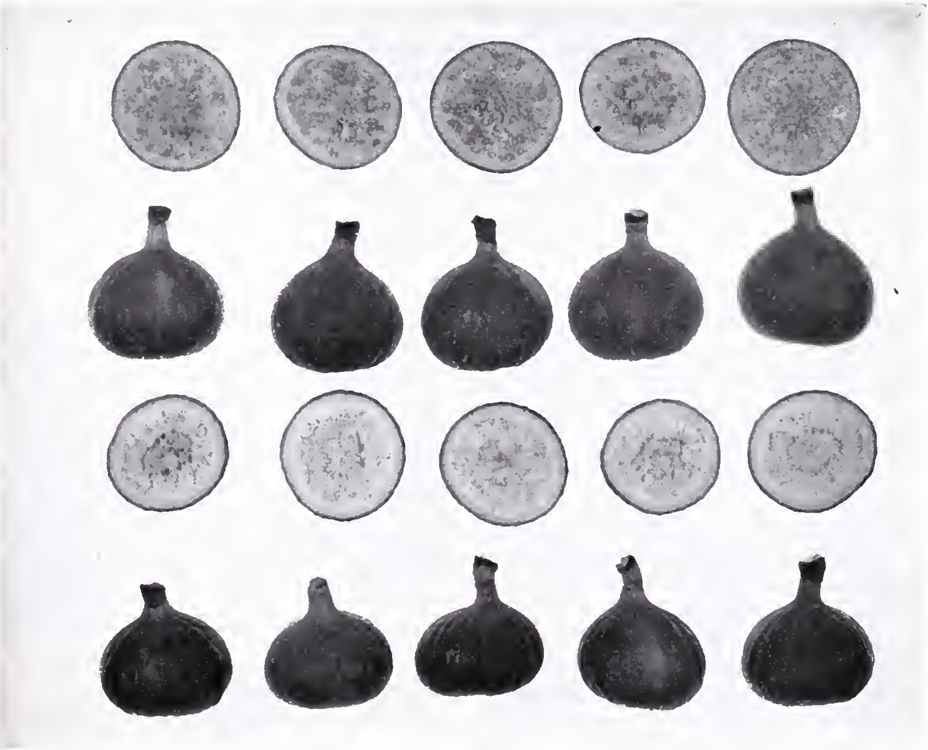
Seeds

Externally, hormone-produced figs appear quite similar to pollinated figs. The two types, however, are markedly different internally. In addition to a difference in color of the pulp, figs produced with the hormone are completely seedless—completely devoid of the little hard *achenes* in which the individual seeds are enclosed. These figs offer a potentially broader market to the producer, since they appeal particularly to those people who avoid figs because of the seeds. Analyses have shown this type of fig to be consistently 5 per cent richer in sugar than those with seeds. Dried "Miracle Seedless Figs" in attractive boxes have been on the commercial market for the past three years.

Although the industry has adopted the use of Fig Fix on a small scale, figs produced with this hormone apparently have a limited market. Processors have been slow to accept seedless figs because they fear consumer resistance to the smooth-textured products made from them. Experimental investigations have therefore been focused on the testing of other hormones, in an attempt to find one which would set the fruit without injury to foliage, and also cause "seed" development to take place—not necessarily seeds that would grow, but little hard things that would seem like seeds to the layman.

Another synthetic hormone, benzothiazol-2-oxyacetic acid, not previously known to be effective in producing fruits without pollination, was found during the 1951 season to meet all the requirements mentioned above. Figs produced with this compound developed "seeds" and had the crunchy texture characteristic of pollinated figs. As a result of a single spray application of this new hormone, the percentage of fruit set on the test trees was 13 per cent higher than on caprified trees. From their external appearance, it was difficult, if not impossible, to distinguish between caprified figs and those produced with benzothiazol-2-oxyacetic acid. Internally, figs produced by means of the compound appeared identical with caprified figs—as far as seed development was concerned—but the color of the pulp in the two types was different; the pulp in figs produced with the hormone was light amber-yellow, in contrast with the typical strawberry-red color of caprified figs.

Thus, the CALIMYRNA fig grower is now in a position where he may discard the age-old practice of caprification and produce either seedless or seeded figs by hormone application.



Courtesy University of California

CALIMYRNA figs about a month before maturity. *Two upper rows,* with seeds, produced by pollination. *Two lower rows,* seedless, produced with Fig Fix.

Photos courtesy Massachusetts Agricultural Experiment Station

Preharvest drop of DUCHESS apples—twenty-four-hour accumulation.

HORMONES FOR APPLES AND PEARS

To control the number, size, and color of the fruits (within limits), and to keep them on the tree till ripe

George S. Avery, Jr.

WHETHER apples are growing in a back-yard garden or in a commercial orchard, it is discouraging to the grower to have perhaps half the entire crop of fruit fall from the tree before it has matured and developed good color. It means a substantial loss, too. Preharvest drop of certain varieties of apples has long been a problem, and one of the first uses of hormone sprays was to check this loss of unripened fruit. There are many hormone preparations on the market for this special purpose (for spray or dust application); among them are App-L-Set, Apple-Lok, Fruit Fix, Fruitone, Parmone, Stop-Drop, and Vitatone. Chemically, they are all naphthaleneacetic acid; as sprays, they are used at a concentration of 10 parts per million (0.001%); as dusts, at 0.1 per cent. Manufacturers' directions accompany the products and cover all necessary points—from weather to dilution.

Time

In brief, preharvest sprays and dusts should be applied just as soon as there is evidence of abnormal preharvest drop of fruit. The drop control sprays are compatible with nicotine sulfate and oil, nicotine-bentonite, etc. A second application is sometimes necessary five days to a week after the first. In no instance have such sprays been effective in reducing or arresting June drop.

Color

An interesting new chemical has been discovered, relatively recently, for the

Control of preharvest drop by hormone spray.

control of preharvest drop; and it seems to have other virtues, too. It is marketed as Color-fix, Color-lok, and Color-Set and is 2,4,5-trichlorophenoxy-propionic acid. It has already been tested in ten states and on a considerable number of varieties; a single application, a week **before** drop is expected, is reported fully effective.

Color-Set is also reported to improve fruit color. The extent of coloration seems to depend on how long before harvest the spray is applied, as well as on the weather before and after spraying. Red varieties are not alone in responding; even the yellow-fruited GOLDEN DELICIOUS and GRIMES GOLDEN develop deeper color while still on the tree. For the present, Color-Set should be considered largely experimental as to color control, but well tested as a preharvest drop preventive.

Varieties

Certain apple varieties are more subject to preharvest drop than others. McINTOSH probably heads the list in most localities where it is grown. In other localities, WINESAP may have a notorious record for preharvest drop. Curiously enough, WINESAP drop is usually poorly controlled by naphthaleneacetic acid preparations; but this variety clings tenaciously to the tree that has a preharvest spray of 2,4-D.

BARTLETT and BOSC pears frequently fall from the tree before ripening; and experience has shown that App-L-Set, Apple-Lok, etc., will control preharvest drop of these fruits.

Caution

In using any preharvest drop spray, it is important not to let treated fruit get overripe before picking it.

Chemical Thinning

It is a paradox of nature that some varieties of fruit need special chemical assistance to stay on the tree until ripe, while the same and other varieties bear flowers and set fruit in such profusion that in their early development they must

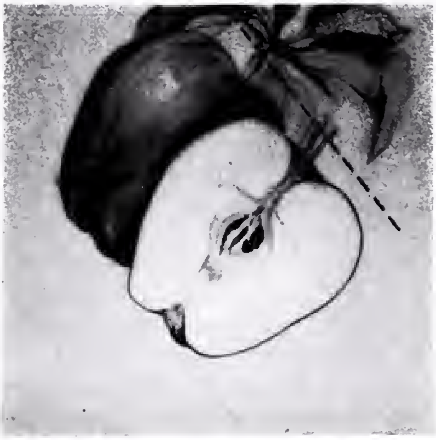
Airplane spraying to control preharvest drop of apples.

Courtesy Central Aircraft Inc., Yakima, Wash.

be thinned. For the professional apple grower one of the time-consuming operations is hand thinning, particularly of varieties that bear heavily in alternate years (for example, Wealthy, Yellow Transparent, and Golden Delicious).

Horticultural researchers have now reduced the thinning problem to a simple spraying operation—with naphthaleneacetic acid, the same synthetic hormone used in preharvest drop control, and at the same concentration. The chemical may be applied when the apple trees are in full bloom or (apparently) any time up to two weeks after petal fall. In addition to causing some of the flowers to drop. it may also cause the new growth to become temporarily twisted and distorted, but it will not burn the new foliage. For the thinning spray, naphthaleneacetic acid may be used alone, or in combination with wettable sulfur, or with wettable sulfur and lime, or with arsenate of lead.

One of the advantages of proper thinning is insuring full crops year after year, whereas inadequate thinning (in numerous varieties) leads to years of heavy bearing alternating with years of low yield or no yield. Inadequate thinning (or none at all) invariably results in small-size fruits.



Courtesy E. I. Du Pont de Nemours & Co.

In premature drop of apples in the fall, the fruit separates from the stem at point indicated by dotted line. This preharvest drop in many varieties can be controlled by hormone sprays.

TO HASTEN THE RIPENING OF BANANAS AND APPLES PICKED GREEN

Workers in the United States Department of Agriculture have found that the ripening of green bananas can be hastened by the use of a mixture of 2,4-D in water. Green bananas dipped in the mixture or sprayed with it develop the usual ripe color and flavor in two to five days. By similar treatment, yellow apples (such as Grimes Golden), picked before they are ripe, can be made to ripen in about half the usual time. Apples treated in this way should be used as soon as they are ripe.

Spraying navel orange trees to control preharvest drop of fruit. Truck with hydraulic tower for spraying in tops of trees.

Photos author courtesy

"TYING" ORANGES ON THE TREE

The use of chemicals to reduce preharvest drop of oranges, lemons, and grapefruit

William S. Stewart

HARVESTING oranges the year round in California is accomplished by growing WASHINGTON NAVEL oranges, which have ripe fruit from November to May, and VALENCIA oranges, which have ripe fruit from May to November. With both varieties there may be a continuous small amount of fruit drop throughout the harvest season. This is called "preharvest drop"; after dropping, the fruit is practically worthless for marketing since it is bruised and has a short storage life. In addition, toward the end of the season there is usually a heavy fruit drop which is nearly always severe for NAVEL oranges and occurs to an undesirable extent with VALENCIA oranges. With NAVEL oranges as much as one fourth of the entire crop may be lost by a severe preharvest drop late in the season. It is cause for despair for growers to see the fruit they have labored to grow, drop on the ground and become a loss just as it is about to be picked. For them that fruit is the culmination of nine to eighteen months of guarding against pests and freezes and of a careful routine of irrigation and fertilization. The value of a means of reducing this loss is obvious.

In 1941 the apple growers solved a similar problem by spraying their trees with a plant hormone—naphthaleneacetic acid—ten days to two weeks before the drop was expected. Although this treatment resulted in great savings for the apple growers by reducing apple drop, it had no significant effect in reducing orange fruit drop in California.

Control by 2,4-D

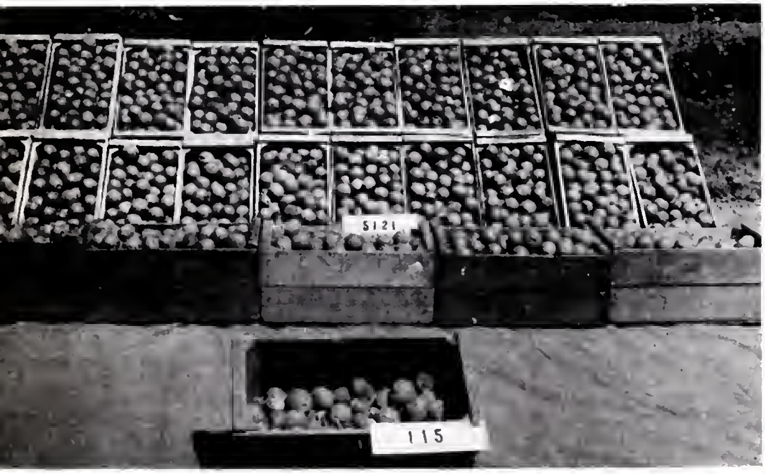
In 1945 another plant hormone, 2,4-D (2,4-dichlorophenoxyacetic acid) became generally available, and its effectiveness as a weed killer is now well known. It may not be so widely realized, however, that when 2,4-D is applied at 8 parts per million (abbreviated "8 ppm"), or less than one-hundreth the strength used for killing weeds, it can induce beneficial responses instead of so disorganizing the functions of plants that they die. With citrus fruits it was found that 2,4-D at concentrations as low as 8 ppm in a water spray or 4 ppm in an oil-water emulsion spray delayed the preharvest drop; it has now become standard orchard practice in California to spray the trees with these very minute amounts of 2,4-D whenever a fruit drop is anticipated, or even after it has begun. 2,4-D reduces preharvest drop of Washington Navel and Valencia oranges, and of grapefruit and lemons. The drop has been known to be reduced as much as 97 per cent, although a reduction between 30 per cent and 60 per cent is usually obtained. It is estimated that during the past year more than three fourths of the citrus acreage in Los Angeles County was sprayed with 2,4-D for fruit drop control.

Preharvest drop of citrus fruits may be delayed as long as six months by a single 2,4-D application. Spraying Washington Navel orange trees in September with 4 ppm 2,4-D in an oil-water emulsion resulted in reduced fruit drop as late as May of the following year.

The manner in which 2,4-D prevents the drop is not fully understood. Apparently it delays the maturity of the cells in the tissue that holds the fruit to the stem. When these cells mature, their walls weaken, and the weight of the fruit causes them to break. If their maturity is delayed, the walls of these cells remain strong and the fruit drop is prevented.

Method

In practice the 2,4-D is used for spraying citrus trees just as it is formulated for weed control except that it is greatly diluted. In 500 gallons of water, for example, one needs only two tablespoons of an "amine" form of 2,4-D ("2,4-Dow Weed Killer, Formula 40," for example) or three tablespoons of an "ester" form of 2,4-D ("Esteron 44"). The cost of this amount of 2,4-D is less than ten cents; and this volume of spray is ordinarily sufficient for 10 to 20 trees, depending on their size. Since 2,4-D has been found to be effective in reducing preharvest drop when sprayed on trees in combination with other spray chemicals, it is usually applied with them as a mixture; thus the cost of application is reduced. When 2,4-D is added to oil-water emulsions used for pest control, it counteracts the tendency of the emulsion spray to cause fruit and leaf drop. Thus far no spray chemical has been found that cannot be applied along with 2,4-D. Generally the mixtures are applied as drenching sprays, by means of orchard spray machines. Sometimes the volume of spray is reduced, but then the concentration of 2,4-D is increased so that the *amount* of 2,4-D per tree is approximately the same. This procedure reaches its ultimate in aero-



Preharvest drop from NAVEL orange trees. *Above*: a month's drop from forty trees not sprayed. *Below*: a month's drop from forty trees of similar size, sprayed about a month before dropping ordinarily begins.

O. K. Anderson, author courtesy

plane or helicopter applications, where the volume may be reduced to 5 gallons per acre, but the concentration increased to 2400 ppm. Thus far 2,4-D has not been commercially applied on citrus fruits by air, although experiments show that this could be done effectively.

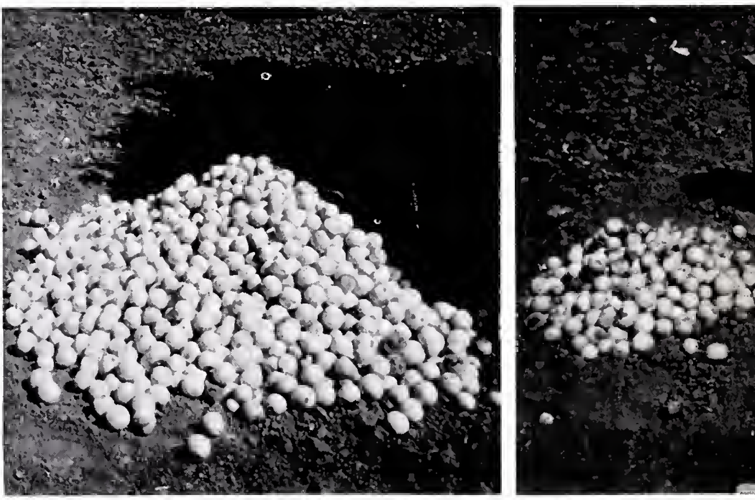
Disadvantages

Usually, along with the good there is the bad; and 2,4-D, even at 8 ppm, seems to be no exception. Two objections have been raised; one, that sprays containing 2,4-D cause a twisting, curling, and deformation of any very tender young leaves present at spraying time. This factor has not become serious in the use of 2,4-D, however, since the leaf curling can generally be avoided by making the application between flushes of leaf growth. Even when one flush of leaves has been deformed by 2,4-D, succeeding flushes are normal unless an excessive amount was applied. Fruit yield records show no bad effects from 2,4-D applied annually for three years.

The second objection is that 2,4-D delays the drop of undesirable cull fruit along with the sound marketable fruit. There is thus an extra charge against 2,4-D for the picking and grading out of this fruit; but it is generally found that the saving in marketable fruit is many times greater than the charge for holding the cull fruit on the tree. In spite of these two objections, the California growers of both Navel and Valencia oranges have a tested means of increasing their harvest by control of fruit drop.*

Helicopter spraying NAVEL orange trees to prevent preharvest drop.

The method is entirely practical for amateur growers, for use on one tree or in a small grove.


Preharvest drop from VALENCIA orange trees. *Left,* five weeks' drop from twenty trees not sprayed. *Right,* drop during the same interval from twenty similar trees sprayed two weeks after the heavy drop began.

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*Technical details of this research are available from University of California Citrus Experiment Station, Riverside, California.

Courtesy Hawaiian Pineapple Co., Ltd.

Field of pineapples. *Left,* immature. *Right,* in fruit.

PINEAPPLES AND HORMONES*

A longer fruiting season, and more and larger fruits timed for efficient harvesting

Johannes van Overbeek

SYNTHETIC plant hormones are known to affect tropical fruit crops in a variety of ways. They may promote the blooming of a plant; they may regulate the uniformity of fruit production; and they may delay the dropping of the fruit until it is fully ripe.

The pineapple plant is one which has responded readily to several of these controls by hormones. It produces only one fruit in its lifetime. Under natural conditions, a field of pineapple begins flowering in the fall and continues through winter. Approximately six months after the compact head of flowers begins to form, the fruit is ready for harvest. The age at which a pineapple plant begins to flower depends upon its variety and upon external conditions. Most commercial varieties are capable of producing marketable fruit at an age of about 18 months. Some varieties, such as the Puerto Rican CABEZONA, occasionally reach an age of 5 years before they flower. Such

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*More on the use of hormones in tropical agriculture, as well as other uses, may be found in the 60 pages given to practical application in "Plant Growth Substances," by numerous contributors, available from University of Wisconsin Press, Madison, Wisconsin. 1951. 476 pages. $6.—ED.

Courtesy University of Wisconsin Press

Spraying a pineapple plantation with hormones to induce flowering.

slow varieties can be brought into earlier production by treatment with synthetic plant hormones. These hormones will also cause flowering in very young plants, too immature to flower in the natural season.

In the tropics the growing of plants is not restricted by frost and similar factors which so drastically curtail crop production in our middle latitudes. There is no reason, therefore, why pineapples cannot be produced beyond their natural season, or even throughout the entire year.

Extending the Season

For several decades, pineapple growers have been using various methods of extending the harvest season. First, they began taking advantage of the accidental discovery (in the Azores) that smoke made pineapple plants bloom earlier. Older growers in Puerto Rico still remember how smoky fires were made at night under tents erected over the rows.

This use of smoke for forcing pineapple plants into early flowering has dwindled since it was discovered (in 1939) that the synthetic hormone naphthaleneacetic acid (NA) had the same effect. This compound has been accepted by many growers as the best of the flower-inducing chemicals available at present. Under current commercial practice, approximately an ounce of NA per acre, sprayed on by large mechanized equipment, will induce uniform flowering in the pineapple fields. Only one treatment is required to induce flowering, and the total cost is roughly $5 an acre.

Efficient Harvesting

The advantages of forced flowering in the pineapple industry do not lie exclusively in the extension of the harvest season. The much improved uniformity of flowering, and consequently of fruiting, is of tremendous economic importance. Before the use of hormones to control the time of flowering and fruiting, the earliest and the latest fruits produced in a field during one season might be months

Author courtesy

Large pineapple produced by hormone spray.

apart. Now, the entire field is forced into flower at once, all the fruits are ripe at the same time, and so the whole crop can be harvested at one time. Also, by forcing into flower a larger percentage of the plants in a field, the actual yield of fruit per acre is increased.

Systematic hormone treatments on different fields are carefully timed so that when the harvesting in one field is completed, the crew (with its trucks and other machinery) moves on to the next. The frantic rush, characteristic of the harvesting of most perishable fruit crops, is largely eliminated.

It is now possible not only to predetermine the date of harvest of the pineapple crop, but also to estimate with reasonable accuracy the tonnage a field will produce.

Increased Yield

One disadvantage of the use of NA is that it causes the stem to grow abnormally long and weak. Before the fruit is ripe, this weak stem may bend over and break. Another synthetic hormone, beta-naphthoxyacetic acid, sprayed on after fruit development is well under way, corrects the difficulty. This not only strengthens the stem but also causes a delay in fruit ripening and a consequent increase in fruit weight.

These two hormone treatments, one for flower induction and a later one of a different kind for strengthening the stem and increasing the fruit weight, have been adopted as standard practice in several of the large pineapple plantations.

LITCHI CULTURE MADE PROFITABLE

In the Hawaiian Islands, litchi (or lychee) trees flower and fruit so irregularly that this crop is usually considered to have few economic possiblities. It has been found, however, that flowering can be induced by treatment with naphthalene-acetic acid. In a group of trees used for experiment, flowers were produced on 88 per cent of those treated with hormones, but on only 4 per cent of the untreated ones observed as controls.

In contrast with the pineapple, in which certain hormones promote flower formation directly, hormone-induced blooming in the litchi seems to be due to the suppression of lush young shoots. This indirect type of flower induction is probably due to an accumulation of nutrients which would normally be used in lush vegetative growth; this stored material is then encouraged, through hormonal action, to be used in the production of flowers and fruit.

Johannes van Overbeek

HORMONES IN PLANT BREEDING

To induce or increase seed formation in lilies, lima beans, and cantaloupes

S. L. Emsweller

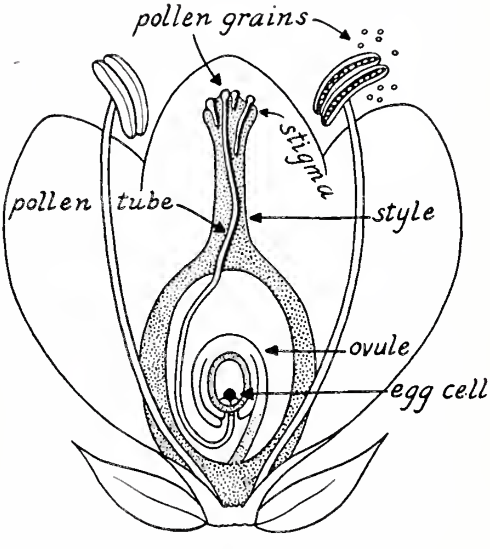
IN developing new varieties of plants by breeding, the breeder sometimes encounters plants that are sterile: that is, they fail to set seed with their own pollen (self-sterile) or with pollen from another variety (cross-sterile). Occasional plants may be both self- and cross-sterile. Such individuals are frequently called "mules"—a term originating from the well-known sterility of the mule, which is so rarely fertile that it can be produced only by crossing the horse with the ass. The authenticated cases of fertile mules can easily be counted on the fingers of both hands. When cross- and self-sterilities are encountered in plants, they are a serious obstacle to further improvement by breeding: the breeder can go no further with such material.

Causes of Sterility

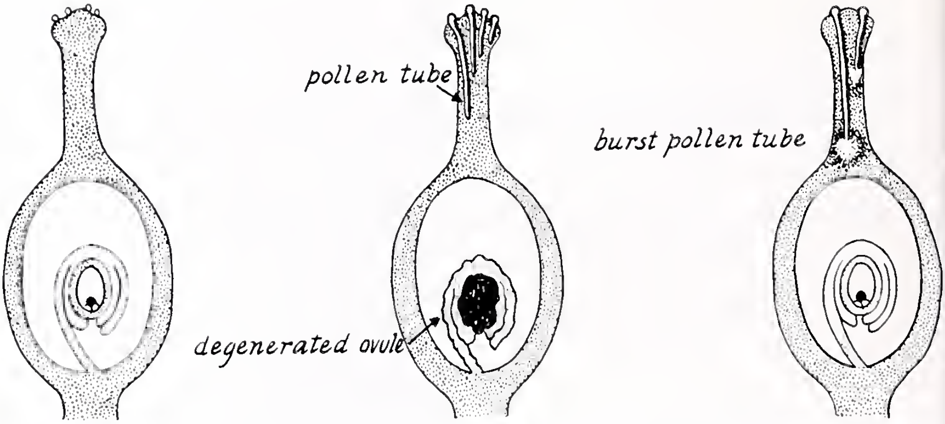
Failure to set seed occurs in many different kinds of plants and is especially common in hybrids. In hybrid plants sterility may be due to the inability of the plant to form good pollen or good egg cells. This often results when two species are crossed and the hereditary material from one parent is unable to cooperate with that of the other in the necessary functions leading to the formation of good pollen and egg cells. In plants that form good pollen, sterility may result from one of several causes: the pollen grains may fail to germinate on the stigma; they may germinate but grow down the style so slowly that they fail to reach the ovules before the latter have degenerated; they may start to grow and then burst in the style; or they may reach the ovule and then be unable to fertilize the egg cell and produce an embryo or new plant.

Incomplete Sterility

In some plants sterility is not complete, but so few seeds are formed per



Flower cut open lengthwise (diagram). A pollen tube has reached the ovule; ordinarily fertilization of the egg cell would follow and the ovule would develop into a seed.



Sterility: three possible causes (diagrams).

Failure of pollen grains to grow on stigma.

Slow growth of pollen tubes, preventing their reaching ovule before egg cell degenerates.

Bursting of pollen tubes in style, preventing further growth.

pollination that large populations can be obtained only by making a very large number of pollinations. It is obvious that the formation and persistence of a fruit are essential if seeds are to be obtained. There are many instances in which fruits start to form after pollination but drop from the plant before viable seed is formed. The dropping of young fruits is one of the chief difficulties encountered in breeding cantaloupes, in which on the average only about 10 per cent of the controlled pollinations set fruit. This is not true sterility, since all crosses between cantaloupe varieties do form some fruits containing viable seed; but the failure of most pollinations to form fruits does greatly reduce the percentage of seed set from each pollination. In lima bean breeding, also, the plant breeder is handicapped by the high percentage of small developing pods that fall from the plant before they mature seed. This entails the making of many hundreds of crosses to obtain a few seeds. The set of fruits and seeds in cross-pollinated cantaloupes and lima beans has been increased by the use of plant hormones.

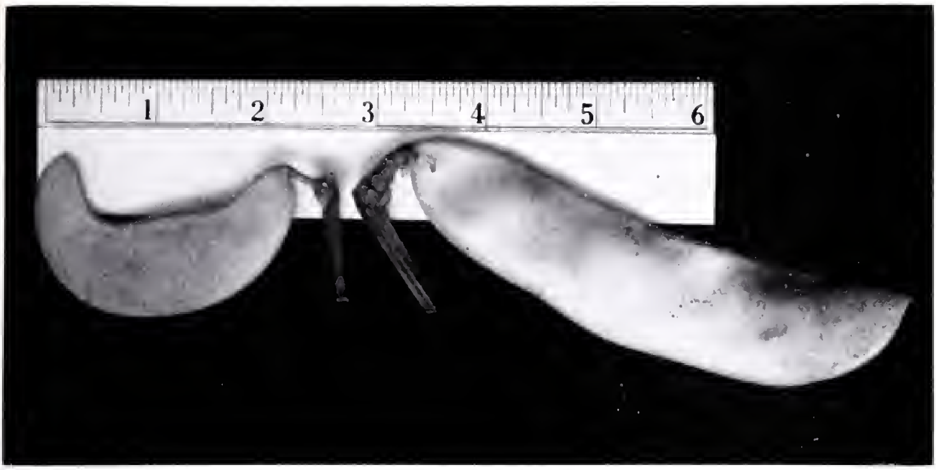
Cantaloupes

For cantaloupe, Burrell and Whitaker used a 1 per cent indoleacetic acid in lanolin (wool fat) mixture on one lobe of the stigma immediately after pollination. They made 164 cross-pollinations, treating 78 and leaving 86 untreated for comparison. The treated pollinations yielded 46 fruits; the untreated, 23 fruits. In other words 59 per cent of those treated with the plant hormone produced fruit set, in contrast with only 27 per cent of the untreated pollinations. Since all of the fruits contained about the same number of seeds, the treatment resulted in many more seeds because of the increase in number of fruits. (See reference 1 at end of article.)

RESULTS OF HORMONE TREATMENT

164
cross-pollinations:

86 untreated → 23 fruits = 27 per cent
78 treated → 46 fruits = 59 per cent



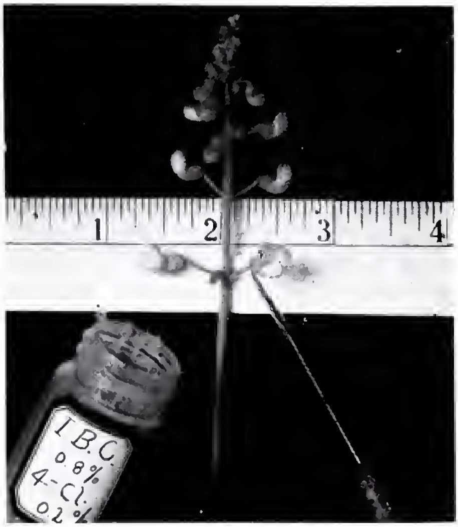
Photos courtesy U. S. Dept. of Agriculture

Pods of lima bean: *left,* from flower not treated; *right,* from flower treated with hormone as illustrated below.

Lima Beans

Wester and Marth applied a mixture of two plant hormones, indolebutyric acid and parachlorophenoxyacetic acid, to scratches made with a needle at the base of lima bean flowers at time of pollination. The plant hormone mixture was prepared by dissolving 0.8 gram of indolebutyric acid and 0.2 gram of parachlorophenoxyacetic acid in 3 grams of warm glycerin diluted with 96 grams of lanolin. A total of 438 flowers was pollinated; half (219) were treated and half were left untreated for comparison. The treated pollinations set 63 pods containing 153 seeds and the untreated ones set 39 pods with 76 seeds. (See reference 3.)

In both cantaloupe and lima bean it is believed that the increase in seeds obtained with the treatment resulted from the plant hormones' reducing the number of pollinated fruits that dropped from the plants.



Lima bean flowers. Scratching base of pistil with needle covered with hormone.

RESULTS OF HORMONE TREATMENT

438 pollinations	219 untreated → 39 pods, 76 seeds
	219 treated → 63 pods, 153 seeds

Easter lily flowers: applying hormone to wound made by breaking petal at base of pistil.

Lilies

Many species of lily fail to set seeds when self-pollinated but form large pods and many seeds when pollen from another variety of the same species is used. Since named lily varieties do not come true from seed, they can be increased only by asexual means; that is, by division of the old bulb, by stem bulblets, by bulbils, or by formation of bulblets on scales detached from the bulb. All individuals of a variety are alike, since they are all pieces of one original bulb; a group of plants originating in this manner is called a **clone.**

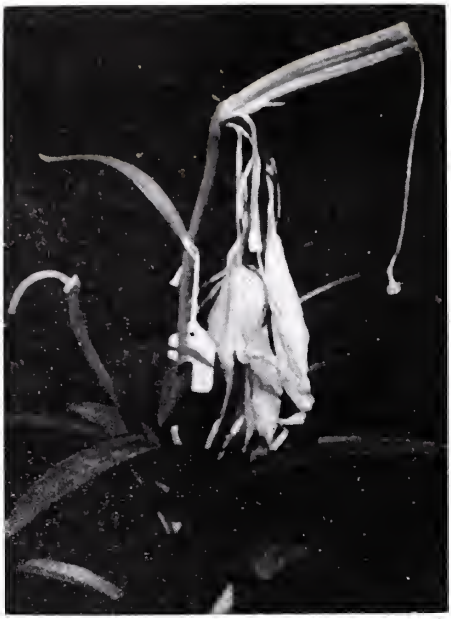
The Easter lily group includes several named **clonal** varieties, almost all self-sterile. Such varieties do not set seed when their own pollen is used but do so when pollen of another variety is applied. At the Plant Industry Station, Beltsville, Maryland, we have conducted extensive tests on self-sterility of Easter lily varieties. In one such test, the varieties CREOLE, CROFT, ESTATE, DIXIE BELLE, ERABU, and GIGANTEUM were used. All except the variety GIGANTEUM failed to set seed when their own pollen was used. Of 43 plants of GIGANTEUM 7 produced some seed.

The self-sterility of several of these Easter lily varieties has now been overcome by use of a plant hormone (see reference 2). Several different hormones were used, but naphthalene acetamide was the most generally effective. A 1 per cent preparation of this hormone was applied at time of pollination to a wound formed at the base of the ovary by breaking a petal where it was attached. The hormone mixture may be prepared as follows: 1 gram of the naphthalene acetamide is added to 3½ ounces of lanolin. The lanolin is melted, and the heating is continued (with stirring) until all the naphthalene acetamide is dissolved. If the lanolin is not heated until it darkens slightly, the hormone will not dissolve. The solution should be stirred well, cooled, and stored in a refrigerator. Sometime before use, it should be warmed to room temperature so that it has the consistency of vaseline and can easily be applied to the flowers.

Treatment was applied to 300 of 750 self-pollinated CREOLE flowers. All the treated pollinations formed pods, but the untreated formed none. In 18 of the pods there were 117 good seeds. In the CROFT variety 48 of 98 pollinations were treated and 48 pods formed; 6 had 119 seeds.

The ACE variety of Easter lily occasionally sets some seed when self-pollinated. In this variety 90 pollinations were treated and 48 were untreated. The treated ones all set pods, containing 2,414 seeds. The untreated pollinations set 9 pods, with 207 seeds.

The hormone treatment has also been used in making difficult crosses between lily species. On lily species other than the Easter lily, 85 cross- and self-pollinations were made. Seeds were obtained from 47; but 16 of these produced seeds only when a hormone was used.



Easter lily pistils: *at left,* small wilted (curved) pistil, not treated, not developing into a pod; *at right,* large seed pod from pistil treated with hormone.

RESULTS OF HORMONE TREATMENT

750 self-pollinations (CREOLE)	450 untreated	→ no pods no seeds
	300 treated	→ 300 pods 18 pods → 117 seeds
98 self-pollinations (CROFT)	50 untreated	→ no pods no seeds
	48 treated	→ 48 pods 6 pods → 119 seeds
138 self pollinations (ACE)	48 untreated	→ 9 pods, 207 seeds
	90 treated	→ 90 pods, 2414 seeds

It is not known just how plant hormones produce these results. Possibly they merely aid in establishing seed pods; perhaps they keep the ovules in good condition long enough for the pollen tubes to reach them. While it is demonstrated that some sterilities have been overcome by plant hormones, there are probably others upon which they will have no effect. It is also possible that plant hormones not yet tested may be more effective than those so far used. Considerably more research in this field is certainly needed.

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2. Use of growth-regulating substances to overcome incompatibilities in *Lilium,* by S. L. Emsweller and N. W. Stuart. Vol. 51, pp. 581-589. 1948.

3. Some effects of a growth-regulator mixture in controlled cross-pollinations of lima beans, by R. E. Wester and Paul C. Marth. Vol. 53, pp. 315-318. 1949.

CHEMICALS FOR WEED CONTROL

Hormone and nonhormone; selective and nonselective; truly poisonous and not poisonous—to plants

Louis G. Nickell

THE chemicals used for controlling weeds can easily be grouped into a few categories, according to their uses.

Some are plant hormones—chemicals that may enter a plant at any point, travel to all parts, and produce a complete killing with a very small amount of the chemical; they are not poisonous to plants in the usual sense of the word. Each hormone usually kills certain kinds of plants but not others, that is, they are generally selective.

Other weed-controlling chemicals travel through the plant and kill all parts but are not classed as hormones. They are truly poisonous to practically all plants if they are used in strong enough solutions.

Still other chemicals, also true plant poisons, kill only the plant parts to which they are directly applied—usually the parts above ground; the underground parts remain alive and send up new sprouts. Some of these poisons are selective.

Hormones

2,4-D, the most famous of the weed-killing hormones, is used mostly to kill broad-leaved weeds when they are in combination with narrow-leaved crops—for example, dandelions and plantain in a blue grass lawn. It is harmless to man.

2,4,5-T* is a close ally of 2,4-D and is equally safe to use. This compound is very effective in destroying woody plants. Its use in clearing undesirable brush patches and at the same time allowing the grass cover to remain is a tremendous boon to the farmer who is trying to reclaim pasturage or to anyone who has brush encroaching on a grassy area.

Nonhormones—Selective

Dinitro compounds, not hormones, but selective in their effects on plants, are somewhat similar to 2,4-D in selectivity; that is, narrow-leaved plants such as grasses and cereal crops are left relatively undamaged, while weeds such as mustard, chickweed, ragweed, and wild lettuce are killed. These compounds are effective when applied to the foliage. Because they are less selective in the presence of moisture, they should be applied only when the plants are dry. They are irritating to the skin and respiratory passages, and in large quantities are poisonous to man.

Oil has long been known to have a selective action in killing plants. But it was not until 1943 that kerosene, accidentally spilled on a row of carrots, was observed to kill the weeds but leave the carrots unharmed. Since then, Stoddard Solvent — synthetic paint thinner — has been accepted as a good carrot-weeding material. There are many variable factors in connection with the use of mineral spirits in chemical weeding.

TCA, although not a hormone, is a selective plant killer when applied at high concentrations. It is best known for its effectiveness in destroying such insidious pests as quack grass and Johnson grass. These grasses are highly resistant to 2,4-D. TCA must be used with care, as it is very irritating to human skin.

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*The meaning of this and other abbreviations are given on page 58. . . . Ed.

IPC has proved to be an effective compound for killing grass and other narrow-leaved weeds in broad-leaved crops such as cotton, beets, radishes, and lettuce. Since it has no effect when sprayed on leaf surfaces, it must be applied to the soil. IPC is most effective when applied before, or just after, the seeds have germinated. This soil treatment for weeds is known as pre-emergence treatment. There is no evidence that IPC is harmful to man.

Potassium cyanate is the active ingredient in most crab grass killers. This chemical, relatively harmless as far as human beings are concerned, is effective under certain circumstances when applied to crab grass infestations in lawns, and may be somewhat more reliable than phenyl mercuric acetate.

Nonselective Weed Killers

The many nonselective weed killers are general-purpose materials which serve many uses. In some cases they are used to kill all vegetation. As soon as their poisonous effect is gone, new plantings can be started.

Ammate has become very important because of its use in eliminating poison-ivy as well as its use against undesirable hardwood trees particularly in the southern parts of the United States. If ammate is used to kill poison-ivy growing on a desirable tree, the spray should be confined to the poison-ivy foliage as much as possible and should not be allowed to soak the bark of the tree. The skin of the operator should be protected from the irritating action of this chemical.

Commercial Preparations

For each chemical mentioned, such as 2,4-D or potassium cyanate, there are innumerable commercial compounds offered. A list of about 225 of them, classified by uses, begins on page 101. Careful study will show that most of them fall into the categories mentioned here; **but this general information is useless unless one heeds the manufacturers' specific instructions** given on the container or in accompanying literature. Timing, concentrations, weather conditions, all add up to possible variations in results. The mistiming of application of a weed killer may mean the difference between success and failure. When the materials are used without sufficient care, "selective" chemical weeding can be disconcertingly nonselective—and painfully costly.

Weed List

An alphabetical list of 454 weeds, with the chemicals used for their control, begins on page 58.

CAUTION

Wind Drift: 2,4-D and other weed-killing chemicals drift readily in the wind—coarse sprays less readily than dusts and fine sprays, and any dust or spray (of course) less readily on a quiet day. Wind drift of very small amounts of 2,4-D will cause young leaves of ornamental plants to become distorted and growth to be temporarily retarded; it may kill some plants.

In general, therefore, the weed-killing hormones should not be used very near ornamental plants. Great care must be taken if they are used on lawns near ornamental plants.

Before long, garden weed control will be greatly simplified by chemicals newly discovered and yet to be discovered; but meanwhile, for the ornamental garden the hoe, the cultivator, and mulches are safer.

Washing Sprayer. Because 2,4-D is so potent—even in extremely small amounts—in distorting and otherwise affecting growth, it is of the utmost importance not to use the same sprayer interchangeably for 2,4-D and for solutions to be applied directly to ornamental plants or crops—solutions used to control insects and diseases, for example. It is best to have one sprayer for 2,4-D alone; but if this sprayer is ever used for desirable plants, it must be thoroughly cleaned before such use. See **Caution** on page 48.

Courtesy New Jersey Agricultural Experiment Station

Power sprayer applying 2,4-D on large lawn area.

WEED-FREE LAWNS

Best achieved through proper culture methods in combination with hormone weed killers; procedures for the Northeast and the Middle West

Ralph E. Engel and Gilbert H. Ahlgren

A UNIFORMLY green, weed-free lawn of healthy grass is a pleasing sight to behold. Such a lawn or grass cover is not obtained by wishful thinking: it is the product of careful planning and of a program that encourages the grasses to the detriment of the weeds.

More Grass—Fewer Weeds

A dense, healthy grass growth is the best means of controlling weeds in lawns and other grassed areas. Certain cultural practices are helpful toward this end.

1. **The best-adapted grasses** should be chosen for seeding, whether a new lawn is being made or an old one patched up. In the northeastern United States these are Kentucky blue grass, red fescue, and colonial bent grass. Sunny lawns should be seeded to a mixture high in blue grass, whereas red fescue is superior in shade.

2. **Adequate lime and plant food** must be supplied to keep the grass in vigorous growth. For somewhat acid soils the lime requirement is about 50 pounds of ground limestone per 1,000 square feet every two or three years. The lawn should have annual treatment with plant foods containing nitrogen, phosphorus, and potassium, the elements commonly lacking in most soils. The plant food may be 15 to 20 pounds of a 5-10-5 fertilizer per 1,000 square feet of lawn, or 10 pounds of an 8-6-4 mixture. Such treatment is best applied in the early fall and again in the spring.

3. **Close mowing should be avoided.** More lawns are weakened by close clipping than by any other factor. If the mower is set at 1½ inches or higher, mowing may be done as often as is desired. Mowing at a height of 2 to 3 inches from May through August will successfully eliminate crab grass problems within two or three years.

4. **Watering** should be done only as it is needed, and then enough water should be applied to wet the soil to a depth of 5 or 6 inches. Occasional light watering encourages the germination of weed seeds, especially crab grass.

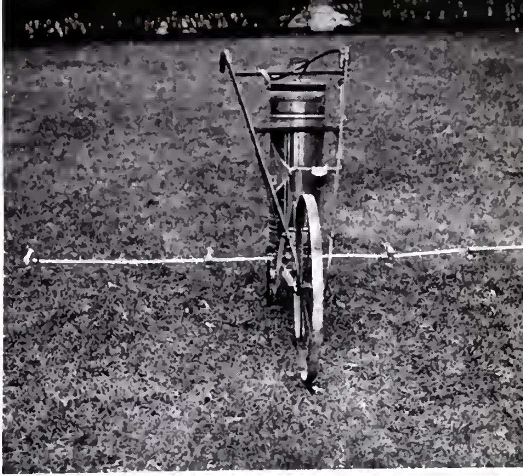
Common Lawn Weeds

Weeds often found in lawns in the Northeast (as well as in the Middle West) are **dandelion**, narrow- and broad-leaved **plantain**, **chickweed**, and **crab grass**. The dandelions and plantains are perennials and may infest the lawn most of the growing season; crab grass is an annual, becoming a pest in the summer, dying out with the first fall frosts.

How to Destroy Weeds in Lawns

Hand weeding is practical on small lawns or on lawns that have only a few weeds, but it is too laborious on large lawns or on areas heavily infested.

Chemicals are good for controlling lawn weeds on a large scale. The directions on the container should be carefully followed. Chemicals should not be applied in extremely hot or dry weather. It is desirable to make trial applications on a small section of the lawn, to determine if the degree of injury is tolerable.



Photos Courtesy Michigan State College

Home-built lawn sprayer with boom of ¼-inch pipe, and flat fan nozzles.

Hand cultivator converted into carrier for sprayer.

Three-gallon compressed-air sprayer to be mounted as indicated.

BROAD-LEAVED WEEDS such as dandelion and plantains are readily killed by being sprayed with a solution of 2,4-D. The usual rate of application is ½ ounce of the chemical per 1,000 square feet of lawn, or 1 to 1½ pounds per acre. The 2,4-D is commonly used as a spray at the rate of 10 to 100 gallons per acre, depending on the kind of sprayer used. It may also be applied in the dry form, mixed with fertilizers; Scott's "Weed and Feed" is an example of a ready-made mixture. Directions come with the commercial preparations.

Caution. Either the spray or the dust may drift in the wind and severely injure or kill nearby garden and ornamental plants. Special precautions must be taken to prevent this.

Time. The broad-leaved weeds may be killed with 2,4-D at any time when they are actively growing. For a lawn that is subject to invasion by crab grass, early fall is the best time for 2,4-D treatments.

Reseeding and fertilizing should be done as soon as the broad-leaved weeds are killed. A blue-grass-fescue mixture is good to prevent crab grass from occupying the bare spots left by the death of the broad-leaved weeds. By the following spring the desirable grasses will be established and will aid in keeping out weeds during the following summer.

CRAB GRASS can also be controlled by chemicals such as phenyl mercury compounds and potassium cyanate.

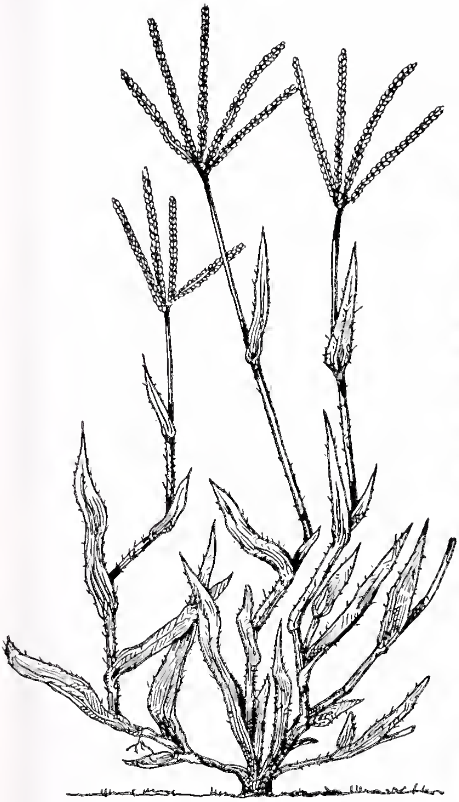
Phenyl mercury materials must be applied from three to five times. These materials are sold as Ortho Crabgrass Killer, Scutl, and Tat-C-Lect for dry application; and as PMAS, PMAS-10, Puraturf, Seltox, and Tat-C-Lect, for spray application. The spray method has given better and more consistent results. A total of 2 to 2½ ounces of a 10 per cent active material is used for 1,000 square feet for blue grass lawns at each

Dandelions and 2,4-D. *Above,* not treated. *Middle,* 10 days after application of dust form of 2,4-D. *Below,* 3 weeks after treatment.

Courtesy Scott's Lawn Research

application. Each commercial product is accompanied by full directions. The phenyl mercury materials are poisonous and expensive, but they control crab grass with a minimum of injury to the lawn if properly used.

The **potassium cyanate** preparations are nonpoisonous and are most successful on a Kentucky blue grass lawn. They may produce temporary discoloration, but the turf recovers quickly if the dosage is not excessive and if growing conditions are favorable.



Courtesy New Jersey Agr. Exp. Sta.

Crab grass with seed heads.

Potassium cyanate is used at rates of 3 to 4 ounces in 8 to 10 gallons of water per 1,000 square feet. Its effectiveness is increased by adding a wetting agent, and most commercial preparations contain one. Repeated application may be required for complete control.

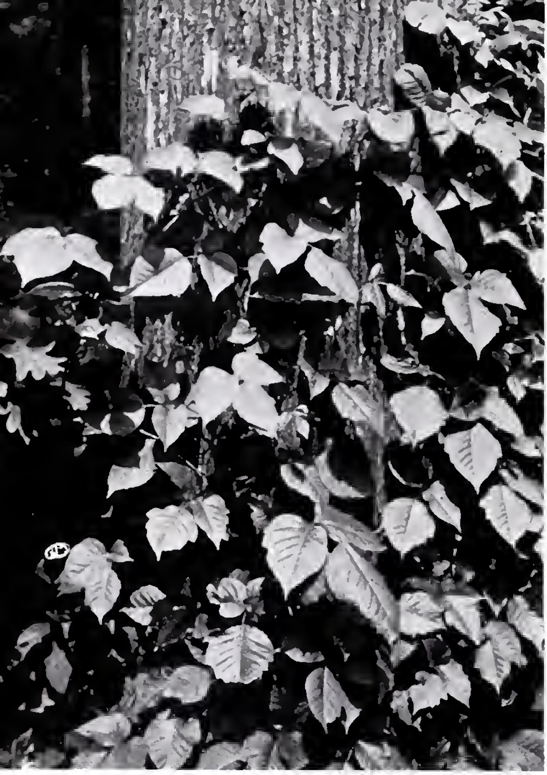
English plantain in bloom.

Keeping the lawn well fed and avoiding close mowing constitute a major step toward controlling the weeds. The use of chemicals is a supplementary method giving quick but only temporary relief.

Plantain leaves sprayed with 2,4-D curl before dying.

Photos Courtesy New Jersey Agr. Exp. Sta.

Spot spraying is a convenient means of eradication where dandelions and plantain are not too numerous in lawns.



POISON-IVY and RAGWEED

How to kill poison-ivy with 2,4-D or Ammate; how to make ragweed harmless with 2,4-D

A. E. Hitchcock

Lush growth of poison-ivy at base of tree.

ONLY a few kinds of plants that are noxious or detrimental to health grow both in the city and in the country. Plants poisonous to the touch are **poison-ivy, poison-oak,** and **poison sumac.** Of the plants that cause hay fever by their large quantities of wind-borne pollen, the worst offenders are the common and giant **ragweeds;** these two kinds of plants produce most of the pollen that is responsible for hay fever in the northeastern states. Only about 10 per cent of hay fever pollen is attributed to grasses; the main grass offenders are June grass, orchard grass, redtop, and timothy, which flower in the early summer.

Knowing the Plants

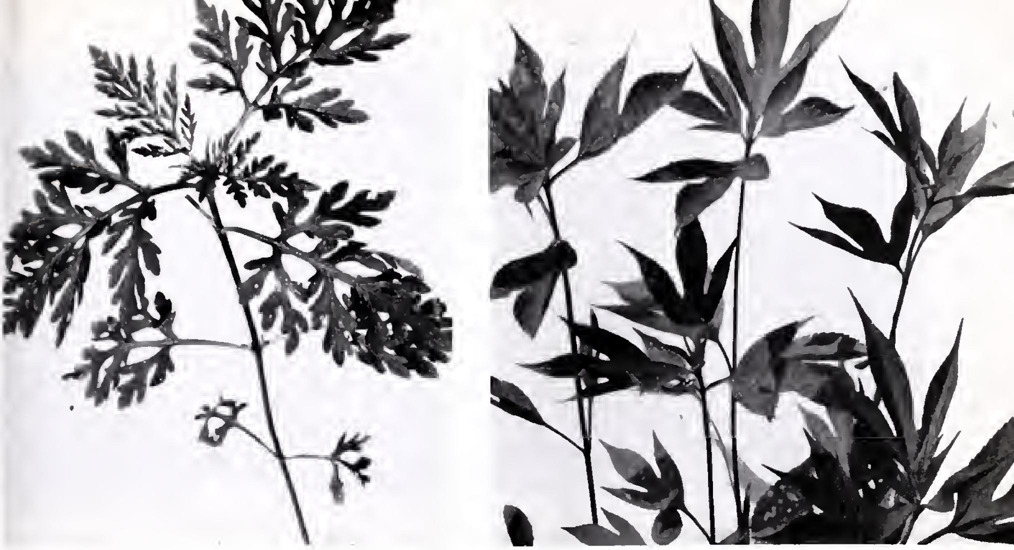
Poison-ivy and ragweed can be controlled by means of chemicals that are not hazardous to animals or to people, but they must be recognized at all stages of growth and in their various forms if they are to be controlled. Poison-ivy in particular occurs in variable forms. It may be vinelike or shrublike; margins of the three separate leaflets may be smooth or irregularly notched; and the leaflets vary in length from 2 or 3 inches (in full sunlight) to 6 inches or more (in shade or in rich soil).

The Chemicals

The two chemicals most commonly used to kill poison-ivy are 2,4-D (known under many trade names) and Ammate. **2,4-D** is relatively cheap, kills poison-ivy slowly, and causes little or no permanent damage to grasses. **Ammate** is more costly but kills plants quickly, including grasses. Which chemical to use generally depends upon local conditions. The preferred formulations of 2,4-D are those containing either amine salts, or esters that are of low volatility. Directions for making spray solutions accompany each product on the market.

Poison-ivy

One-half to one per cent 2,4-D is an effective concentration for killing poison-ivy under practically all conditions. It



Roche photos

Ragweed as it appears up to August 1. *Left,* common ragweed. *Right,* giant ragweed.

is poor economy to use solutions weaker than ½ per cent. An equally good killing can be accomplished by using Ammate at the rate of 1 to 2 pounds per gallon of water, plus 1 level tablespoonful of dishwashing type of detergent. In either case, the foliage of poison-ivy must be thoroughly covered with the spray solution. May through July is the preferred time of the year to spray poison-ivy; plants growing in shade are generally more difficult to kill than those exposed to full sunlight.

Caution—for the Operator

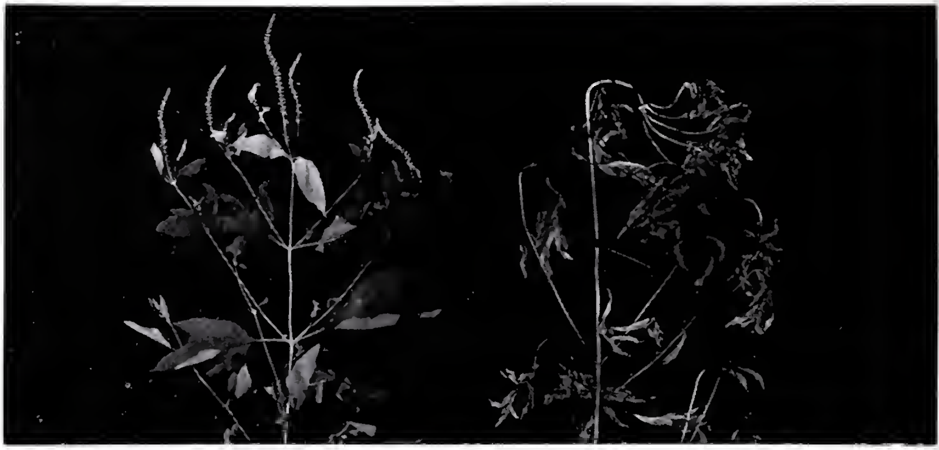
Anyone attempting to kill poison-ivy should be relatively resistant to it; the poisonous substance of the plant is of an oily nature and hence difficult to remove from the surface of the skin. Removal should be attempted as soon as possible after exposure, before the oily poison has time to penetrate to the inner layers of the skin. Complete removal of the poisonous oil from the skin requires several applications of a heavy lather of a soap which is itself free from oil. Old-fashioned **yellow** laundry or kitchen soap is good. It is wise to use **cold** water for making the lather, and to lather the entire body before rinsing any part of it.

It is important to understand that one can acquire the poisonous substance on the skin without actually touching the plant—merely by handling clothes or tools that have been in contact with it. Such articles should be carefully cleaned or disposed of without direct handling.

Ragweed

Ragweed does harm to human beings only by means of its pollen. Hence its control consists in preventing flowering, regardless of the percentage of plants killed. The plants can be prevented from forming pollen if they are sprayed with 2,4-D before their flowering time, which is between August 15 and 20 in New York State. All sizes of ragweed plants flower at the same time each year—when the days reach a certain length. If 2,4-D sprays are applied in June, when the plants are small, the cost is considerably less than spraying large plants later in the season. Ragweed is an annual plant, reproduced only by seeds; hence plants that do not flower cannot be perpetuated.

Ragweed is more sensitive to 2,4-D than poison-ivy; hence considerably lower concentrations can be used for its control. A 1/10 per cent solution of 2,4-D is satisfactory for controlling ragweed, whereas at least five times this strength (½ per cent) is recommended for killing poison-ivy.



Courtesy Boyce Thompson Institute

Giant ragweed August 21. *Left,* not sprayed, has produced flowers with pollen. *Right,* sprayed with 2,4-D August 1.

Caution—for Other Plants

Special precautions should be observed in spraying poison-ivy and ragweed. These noxious weeds are frequently located near gardens or farms; and wind drift of the spray must be prevented from reaching any nearby ornamental or crop plants, because most of them are sensitive to 2,4-D. If the equipment used for 2,4-D is used also for spraying insecticides or fungicides, it must be thoroughly cleaned before being used for ornamental or crop plants. Washing the tank, tubes, and nozzle with ammonia water (1 tablespoonful of household ammonia per gallon of water), followed by several rinsings with clear water, is generally sufficient; but it is really more convenient to use a separate sprayer for 2,4-D.

Use of these chemical weed killers can greatly reduce the amount of human suffering caused by these two groups of noxious plants.

MALEIC HYDRAZIDE (MH)

An interesting chemical commonly referred to as MH is being used in many scientific experiments. It is not a hormone, but research indicates that it is likely to be an effective growth inhibitor and herbicide, in many ways similar to plant hormones.

It has been found valuable for killing wild onion, wild garlic, crab grass, Johnson grass, quack grass, Russian thistle, knotweed, mustard, and other weeds.

It can be damaging to a score of crop plants, from alfalfa to cotton (wheat oats, barley, rice, soybeans, peanuts, an others).

It prevents sprouting in storage o onions, potatoes, carrots, sugar beets, an other underground vegetables.

One of the most interesting of its pos sible uses is for temporary growth inhibi tion. For example, it may prove practica to restrain the growth of certain kinds o hedges by spraying with MH, and thu eliminate much of the laborious trimming

CRAG HERBICIDE 1

A new weed killer for horticultural crops—strawberries, raspberries, asparagus, and ornamental trees and shrubs

Lawrence J. King

Strawberries

IMAGINE a planting of strawberries that has been held practically weed free from a short period following plant setting, through the entire growing season, and into early winter, with perhaps only one or two cultivations. Consider what a labor-saving factor this would be. Sprays of CRAG Herbicide 1 can make this a reality. CRAG Herbicide 1 is sodium 2,4-dichlorophenoxyethyl sulfate.

The strawberry plants are not injured: the new herbicide has the unique property of being noninjurious to plants when sprayed or dusted directly on the foliage at concentrations that will kill weed seedlings as they germinate in the soil. Therefore, injury by contact with foliage, either to crops in fields being treated or in adjoining fields as a result of drift, is minimized. This is in dramatic contrast with 2,4-D compounds, which may cause serious damage by foliage absorption or by spray or vapor drift.

Tests at the New Jersey, Michigan, and Iowa experiment stations and elsewhere have shown the effectiveness of CRAG Herbicide 1 in weeding strawberries. Yield records have revealed no adverse effects from the sprays; and the labor required to maintain weed-free plantings has been reduced as much as 76 per cent when this chemical was used. It is readily soluble in water, and spray volumes of about 40 gallons per acre are recommended; only about 3 pounds per acre are required in the lighter soil types.* The soil should be newly cultivated and weed free just prior to spraying; established weeds are not controlled. Weed control lasts for a period of three to six weeks.

Asparagus

Extensive field trials on asparagus plantings in New Jersey have shown excellent weed control, with no adverse effects on yield or quality. The herbicide is applied in early spring, following cultivation and prior to spear emergence. Following harvest, additional applications are made to control weeds during the fern stage of the asparagus. Generally three or four applications, of 2 pounds per acre each (about ¾ ounce per 1000 square feet), should be sufficient for the season.

Raspberries

In Iowa, new plantings of LATHAM (red) and BRISTOL (black) raspberries that had been cultivated and were weed free were sprayed with 4 and 6 pounds per acre (roughly 1½ and 2 ounces per 1000 square feet). Excellent weed control was obtained and no injury to the new sucker growth was observed.

Ornamentals

In Iowa nurseries, tests on 3-year-old seedlings of American arbor-vitae (*Thuja occidentalis*), on third- and fourth-year stocks of juniper (*Juniperus procum-*

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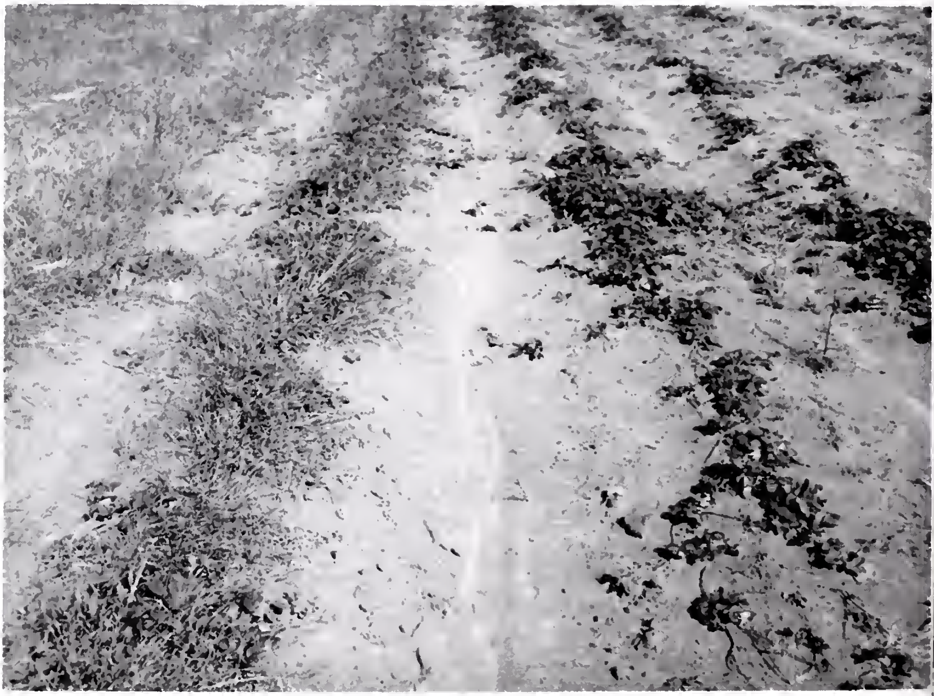
*For amounts for smaller areas, and other details, see p. 51.—ED.

bens) and red cedar (*Juniperus virginiana*), and on second-year lilac (*Syringa*) and mock-orange (*Philadelphus*), have given excellent weed control with no injury to the young trees or shrubs. Rose plantings have also been successfully weeded.

In Michigan and Florida, test applications of 4 pounds per acre (about 1½ ounces per 1000 square feet) one week following planting of gladiolus bulbs gave excellent control and reduced the amount of labor in later cultivation by 90 per cent.

While it would appear that this new herbicide might be used on certain herbaceous perennials and annual flowering plants, no recommendations or directions for its use have yet been made. Small-scale tests might be made by anyone who is willing to risk possible injury to his plants for the sake of experimentation.



Courtesy New Jersey Agricultural Experiment Station

Strawberry weeding with Crag Herbicide 1. *Left* rows cultivated only. *Right* rows cultivated once, then sprayed three times.

CONTROL OF WILD GARLIC

Eradication of garlic from lawns and pastures can be achieved by three sprayings at yearly intervals in the spring (mid-April for Pennsylvania). The first spray should be 1 to 1½ ounces of an amine salt of 2,4-D (or ½ to 1 ounce of an ester of 2,4-D) in enough water to permit even distribution over 1200 to 1500 square feet of lawn (about 3 gallons o water). This should be followed, the nex year, by ½ ounce of an ester of 2,4-D spread evenly over the same area. Th third spraying (in the third year) shoul be like the second and may be expecte to result in complete elimination of th wild garlic.

STRAWBERRY WEEDING

Directions for the chemical killing of weeds of various kinds and ages, at various times of the year, with special reference to mild climates

L. L. Danielson

When new plantings of strawberries go into the garden, the gardener is faced almost immediately with the problem of controlling the weeds that emerge during the cool weather of early spring. These weeds and the succession of late spring and summer weeds are a knotty problem. Add the winter weeds to this, and the gardener must keep a year-round weed vigil.

The time is fast approaching when a major portion of the weed problem in this crop will be solved with chemical sprays. A brief outline of chemical methods which have proved most satisfactory to date is given below. These methods should be used on a trial basis before an entire planting is sprayed, because of the many variables such as weather conditions, soil type, and equipment used for application, all of which may affect results.

Spring and Summer Weeds

Problem: Killing germinating spring and summer annual grass and broad-leaf weeds.

Chemical: Crag Herbicide No. 1.

Preparation of Spray Solution: Dissolve 2 level tablespoons of chemical in 1 gallon of water.

Rate of Spray Application: 1 gallon to 360 feet of 3-foot bed, or 220 feet of 5-foot bed.*

Time of Application: Apply as a soil spray before weeds are up.

New Plantings: Spray seven to ten days after planting and thereafter as needed at monthly intervals, not to exceed five applications per summer.

Old Plantings: Thin, hand weed, fertilize, and spray old plantings after picking is completed. Spray as needed at monthly intervals. Best results are obtained when soil is moist enough for good seed germination.

Caution: Avoid spraying before or during picking season.

Problem: Killing partially grown summer broad-leaf weeds.

Chemical: 40 per cent 2,4-D Amine Salt.

Preparation: Dissolve 1 tablespoon of chemical in 1 gallon of water.

Rate: 1 gallon to 145 feet of 3-foot bed, or 87 feet of 5-foot bed.

Time: During early rapid growth of weeds before they begin to go to seed. Avoid spraying during flower, fruit, runner, and bud development periods of the berry plants. Spray once, hand weed for grasses in four weeks, and apply Crag Herbicide No. 1 as a soil spray for germinating weeds.

Caution: Avoid use of 2,4-D on everbearing varieties of berries.

Winter Weeds

Problem: Killing germinating winter annual grass and broad-leaf weeds.

Chemical: Crag Herbicide No. 1.

Preparation: Dissolve 2 level tablespoons of chemical in 1 gallon of water.

Rate: 1 gallon to 360 feet of 3-foot bed, or 220 feet of 5-foot bed.

Time: When winter weeds begin to germinate, which is usually prior to strawberry plant dormancy in the fall. Best results are obtained when soil is moist enough for good seed germination. Limit to two applications in the fall and allow a month's interval between them.

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*For amounts for larger areas, and other details, see p. 49; photograph on p. 50.—Ed.

Problem: Killing germinating and partially developed winter annual grass and broad-leaf weeds.

Chemical: Sinox P.E. or Dow Premerge.

Preparation: Dissolve 5 tablespoons of chemical in 1 gallon of water.

Rate: 1 gallon to 290 feet of 3-foot bed, or 174 feet of 5-foot bed.

Time: After crop is dormant but before weeds get beyond second-true-leaf stage; preferably during germination if possible. Limit to one application per winter.

Caution: Avoid application later than one month before berry plants begin growth in the spring. Apply only during berry plant dormancy.

Other Chemicals Showing Promise

Two other chemicals have given good results but do not appear in the above outline because they have not been available commercially; these are IPC and Chloro IPC. These chemicals have demonstrated a specific toxicity to purslane, chickweed, and some of the annual grasses. They could be a real asset even if used only for chickweed control and only in the fall, but they appear to hold promise for all-season use.

Spray Equipment Required

All of the chemicals given in this outline of methods are water soluble and may therefore be applied without agitation once they are dissolved. A regular hand pump-up tank sprayer of 2- or 3-gallon capacity may be conveniently used: sufficient pressure to give good foliage or soil coverage is all that is necessary. Nozzles may be of the cone or fan type.

CONTROL OF JOHNSON GRASS

Johnson grass on ditch banks has long been a problem to farmers relying on ditch water for irrigation. Some interesting results have been produced by experimental spraying of 80 miles of ditch bank with sodium TCA (trichloracetate).

Observations indicate that 120 pounds of 90 per cent sodium TCA in 160 gallons of water sprayed on an acre (or 2¾ pounds in about 4 gallons for 1000 square feet) will kill up to 90 per cent of mature, rank Johnson grass a foot high. Best results are obtained when the grass is 10 to 12 inches high and is growing vigorously—usually in September or October.

The result of this spraying is a gradual deterioration of the underground parts. Hence the complete effect may not be noticed until the following spring, when there is a pronounced reduction in the underground spreading of the grass.

Moderately light fall and winter rains apparently help to incorporate the sodium TCA into the top layers of soil and thus aid the killing.

POTATO WEEDING

A new method of weeding potatoes will enable gardeners and farmers to grow weed-free potatoes with minimum work.

Experiments conducted by Ora Smith, Cornell University, show that a single spraying, two weeks after "seed" potatoes are planted but before new potato shoots appear above ground, will discourage weeds for the entire season. The material required for 1500 square feet of bed is ¼ cup of Dow General Weed Killer diluted with 4½ cups of diesel fuel oi and 18 to 36 gallons of water; it must be kept agitated during spraying.

It has long been believed that the soi should be cultivated even when there are no weeds. Smith's experiments showed that potatoes grew just as well withou cultivation if they were grown in the most favorable soil—light loam. In fact tests proved that there was less soil erosion when the surface was undisturbed One hilling, late in the season, to keep the potato tubers covered, was found to be the only cultivation required.

BRUSH CONTROL

Dormant spraying, a new means of easy eradication of undesirable woody plants—by spraying the lower part of the bark, preferably in late winter or early spring

W. R. Mullison

THE entire concept of dormant spraying for brush control is still in its infancy, and there are many phases of this work that are still problems for intensive research. However, extensive experiments over the past few years indicate that basal bark treatment of brush and small trees can be just as effective as the more commonly used spraying of the leaves.

On the basis of current information, most woody plants can be controlled with basal bark treatment, including some kinds that tend to be resistant to foliage sprays. Usually the trees chosen for treatment are 4 inches in diameter or less, because these are most susceptible to the synthetic hormone sprays recommended here.

Method

Basal bark treatment consists in spraying only the basal portions of brush stems or tree trunks, to a height of 12 to 15 inches from the ground. Complete wetting of the lower part of the stem is necessary, because the treatment acts as a chemical girdling mechanism plus the hormone action of the chemical [movement of the chemical throughout the plant]. When brush sprouts are treated, projecting portions of live stumps should be sprayed also. With basal treatment as here discussed, mechanical injury to the bark, such as frilling, is not necessary.

Basal treatment is applied to a relatively small area, and so it is important to use a sufficiently high concentration and adequate volume of the herbicidal, or plant-killing, mixture. Studies are under way to determine the amount of chemical required for killing. Thorough saturation of the basal bark appears essential. With smooth bark such as is encountered on sprouts and small trees, the volume of spray needed for adequate coverage is not high; but on larger trees rough bark can greatly increase the amount of spray solution required to insure penetration of the chemical to the living tissue.

Applications can be made with knapsack sprayers or with power equipment. Low spray pressures minimize the drifting hazard. This hazard from wind drift of highly concentrated oil sprays must be recognized and guarded against, particularly when spraying is done during the growing season. Drift during the dormant season can cause damage to sensitive woody plants adjacent to the sprayed area.

Killers

It is apparent that 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) is more effective than 2,4-D (2,4-dichlorophenoxyacetic acid) for basal treatment of many species; exceptions are a few trees such as willow, which are particularly susceptible to 2,4-D. Mixtures of 2,4-D and 2,4,5-T have given good results, but the evidence seems to indicate that 2,4,5-T is the more effective chemical.

Photos courtesy Dow Chemical Co.

Abundant sprouting from small sassafras stump which was cut the previous fall and received no treatment.

Concentrations of Esteron 2,4,5* in oil, varying from 2 per cent (8 pounds per 100 gallons) upward, have been effective; but over-all results from work done to date indicate that 4 per cent by volume (16 pounds per 100 gallons) should be used, to obtain uniformly good results. For small amounts this is 1 pint Esteron 2,4,5 in 3 gallons of oil. If Esteron Brush Killer is used, it is suggested that

Dead sassafras stump which was sprayed when dormant with 2,4,5-T.

3 to 6 per cent by volume (12 to 24 pounds per 100 gallons) be used. (Esteron Brush Killer contains the new and more effective low volatile propylene glycol butyl ether esters of 2,4-D and 2,4,5-T.)

Carrier

The fundamental difference between basal treatment and foliage treatment is that with the former there are no leaves to absorb the herbicide and pass it into the branches and trunk. In basal applications a *carrier* must be used, which will actually *carry* the herbicide through the relatively impervious bark. Experimental work has shown that oils such as kerosene and fuel oil are particularly effective for this purpose. Emulsions of the esters of 2,4-D or 2,4,5-T have been effective in some instances but have given more variable results and seem to require a higher concentration of chemical than when oil alone is used to dilute the killing substance. At the present time, therefore, either kerosene or fuel oil is suggested as the carrier.

Time

Leaf-spraying treatment is limited to the summer months, but basal bark applications can be made throughout the year. Good results have been obtained from spring, summer, fall, and winter applications. Some of the data indicate that late winter and early spring treatments are particularly effective, when the whole plant is in a dormant, or inactive, condi-

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*The polypropylene glycol butyl ether esters of 2,4,5-trichlorophenoxyacetic acid.

Live stump may be killed by spraying in late winter or early spring.

tion. There is less information concerning summer treatments, but it seems that basal bark applications during the growing season are very effective.

Effects

Following treatment in the dormant season, some kinds of plants may leaf out in an apparently normal fashion, only to show detrimental effects on the leaves sometime during the summer. Other kinds fail to leaf out or do so only partially, and then die back after the bark splits open as a result of the treatment. The rapidity of effect apparently depends on concentration and dosage, the time of the year application is made, and differential species response. The evidence indicates no particular advantage of a quick over a slow killing.

CONTROL OF MESQUITE

Mesquite has been taking over southwestern range lands at an alarming rate. Elimination by mechanical grubbing is prohibitively expensive. But the steady march of this range robber toward complete occupation of range lands has made its effective control a must. To stop its spread, it is necessary to inhibit growth of the young shoots below the soil level.

Experiments made in Texas indicate that the ester of 2,4,5-T and its amine salt give more effective killing than any other material tried. Many methods of application, from hand spraying to application by aeroplane, have shown its effectiveness and its relative cheapness. The best time for spraying appears to be in the spring, when the mesquite reaches its first heavy flush of growth.

Since the effect on the plant is often not fully known for eighteen months, reports of results may be somewhat inaccurate. The trend is apparent, however, and so is worth recording. A killing of 70 to 90 per cent of the tops, along with root killing up to 25 per cent, was obtained by application of ⅓ to ⅔ pound of 2,4,5-T ester in an emulsion of a gallon of diesel oil No. 2 and 4 gallons of water per acre, sprayed from an aeroplane. Spraying from the ground, with a solution of 2000 parts per million of 2,4,5-T ester in water, produced killing up to 60 per cent of tops and roots.

Very effective control (though more expensive) was achieved by mechanical removal of top growth near the ground and spraying of the stumps with a ½ per cent 2,4,5-T ester in diesel oil or kerosene.

Roche

Water-hyacinth. This flowering plant was a ruinous pest in southern waterways until hormone control was discovered.

WATER WEEDS

Chemical means of killing them, submerged or floating, in pools, lakes, canals, or streams

P. W. Zimmerman

THERE are several reasons why we need effective means for controlling water weeds. Because of such weeds, lakes and pools are often rendered unfit for fishing and recreational purposes; drainage and irrigation canals are sometimes clogged by weeds to such an extent that crops are reduced; waterways of the South have been made unfit for navigation, by heavy growth of water-hyacinth (*Eichhornia crassipes*) and alligator-weed (*Alternanthera philoxeroides*); water-chestnut (*Trapa natans*) of the north and central states is becoming as bad as the water-hyacinth of the South; and weed-infested waters make favorable breeding places for mosquitoes.

Water-weed types can be roughly classified as **submerged** or **floating** or a **combination** of these. Water-hyacinth always floats, but water-chestnut is both submerged and floating. Most ponds and lakes in New York have both floating and submerged weeds. Control measures must be adapted for specific needs. In selecting a chemical method it is necessary to consider whether the active ingredient is poisonous to fish, animals, or people. Some very effective chemicals, such as the arsenites, cannot be safely used since they are toxic (poisonous) to water animals and may also contaminate nearby streams and even water-supply systems.

Water-hyacinth and Alligator-weed

The control of water-hyacinth has been accomplished by the use of 2,4-D sprayed from land- and boat-mounted equipment and from helicopter. Approximately 8 pounds of 2,4-D per acre, applied by boat, from the shore, or from the helicopter, has effectively controlled water-hyacinth and alligator-weed in Louisiana. The illustrations show a helicopter in action and the effect produced. Similar results were obtained from sprays applied with low-pressure equipment mounted on boats or on trucks. A knapsack sprayer can be used effectively where small areas are to be treated; a 1 per cent spray solution can be used for small-scale work. 2,4-D has not been found toxic to fish at any concentration necessary to kill weeds.

Water-chestnut

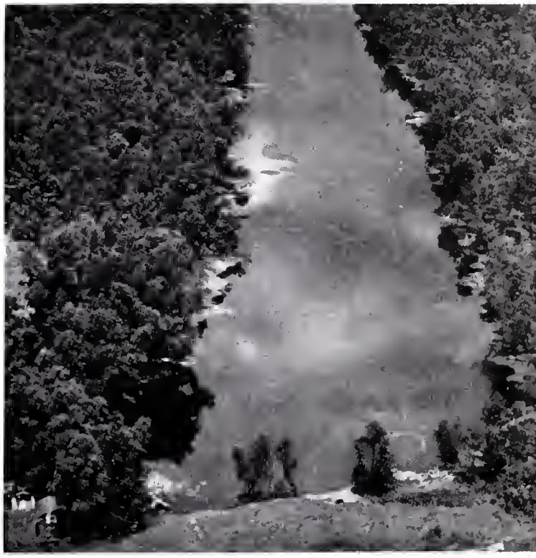
The water-chestnut can be killed with 0.2 per cent to 0.5 per cent 2,4-D, although this plant is anchored to the bottom. The seeds live over winter submerged in mud, and germinate in the spring. The plants sometimes grow 5 to 10 feet before they reach the surface. When they have a sizable leaf area floating, they can be killed by spraying as described for water-hyacinth. One great difficulty in New York has been to spray with an airplane or helicopter without injuring nearby crops. Such spraying must be done when there is low wind velocity. The helicopter is preferable because the down blast from the propeller tends to drive the spray material downward.

Submerged Plants

Submerged vegetation in static ponds and lakes cannot be killed by spraying the surface of the water. The most effective means of controlling the **leafy** submerged water weeds is through the use of chlorinated hydrocarbons. The best known of these is Benoclor. When properly formulated, Benoclor makes a fairly stable emulsion which the water carries some distance before the emulsion is broken. The product now considered best for general water-weed control is known as Benoclor 3-C, which contains the necessary emulsifying agents. It is usually applied from a boat by means of a special pump with an extension pipe to locate the exit at any depth in the water. Benoclor is toxic to wild life and possibly to man. This fact must be considered whenever it is to be used.

Photos courtesy Boyce Thompson Institute

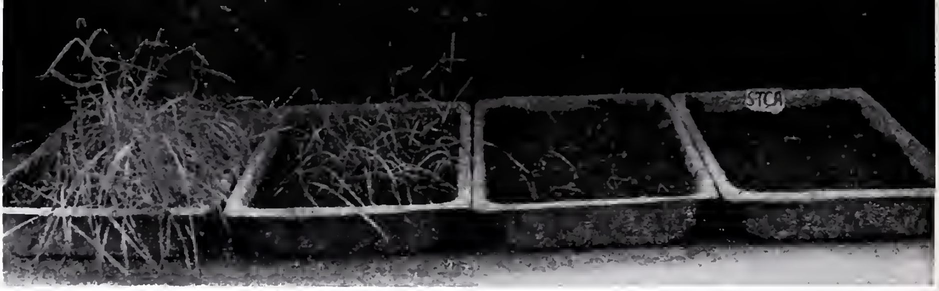
Helicopter applying 2,4 D on water-hyacinths.



Same area as above, seven weeks later (air view).

Algae (very simple plants without leaves) frequently grow abundantly in static waters and swimming pools. The best known method for controlling algae is through the use of copper sulfate. This, too, is toxic to fish, but it is so poisonous to algae that it can be safely used. Approximately 2 parts per million in water will kill algae without killing the fish.

Our hope for controlling weeds in ponds, lakes, canals, and streams has been revived by 2,4-D and other selective weed killers.



Courtesy Michigan State College

Demonstrating control of quack grass with TCA. *Left,* not sprayed. *Next,* sprayed when 6 inches tall. *Next,* sprayed when 3 inches tall. *Right,* sprayed at emergence. Photo one month after treatments.

454 WEEDS AND HOW TO CONTROL THEM

The latest information on the best chemical methods of killing or inhibiting plants that may be undesirable at certain times or in certain places

Louis G. Nickell

THE purpose of this compilation is to present in tabular form recent material on the chemical control of weeds — information published from 1947 through 1951. Emphasis is placed on plant hormones, but other weed killers are included where the hormone-type herbicides have been ineffective. The preferred data are those concerned with the **elimination** of undesirable plants. When such data are not available, we have used those which show **control** of the weed for a **given period** (such as during the early growth of a crop).

In order to economize on space, certain abbreviations are used in addition to those generally understood. These abbreviations and what they represent are given below. Most of these substances are available in the trade products listed on pages 101 to 111. The affected plants are listed alphabetically by scientific names in order to avoid ambiguity. The common names are given at the end, in a separate alphabetized list, with the scientific names under which they are to be found.

Pertinent information, when available, is noted as concisely as possible in the "Remarks" column. For additional information the original references should be consulted.

Explanation of Abbreviations

2,4-D—2,4-dichlorophenoxyacetic acid
2,4,5-T—2,4,5-trichlorophenoxyacetic acid
Ammate—Ammonium sulfamate
DNOC—Dinitro-O-cresol
DNOCHP—Dinitro-O-cyclohexylphenol
DNOSAP — Dinitro-O-secondary-amyl phenol
DNOSBP — Dinitro-O-secondary-butyl phenol
D-T—mixture of equal parts of 2,4-D and 2,4,5-T
EH-1—Experimental herbicide 1 (2,4-dichlorophenoxyethyl sulfate)
IPC—O-isopropyl-N-phenyl carbamate
LPOF—Light petroleum oil fraction
MCPA — 2-methyl-4-chlorophenoxyacetic acid
MH—Maleic hydrazide
Na arsenite—Sodium arsenite
Na salt—Sodium salt
PCP—Pentachlorophenol
TCA—Trichloracetic acid

For alphabetical list of common names of plants, see page 96.

Scientific Name	Common name	Compound	Remarks	References
Abutilon theophrasti	velvet-leaf or velvet-weed	2,4-D	½# per acre, postemergence spray	104, 105
		EH-1		72
Acacia amentacea	blackbrush	Ammate	stump spray	126
decurrens	black wattle	2,4,5-T	ester, foliage spray	51
farnesiana	huisache	2,4,5-T	ester in oil	126
Acalypha indica	copper-leaf or three-seeded mercury	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	73
Acer negundo	box-elder	2,4-D	esters, foliage spray	57, 80
		D-T	mixed esters foliage spray in oil, on cut surfaces	97 80
rubrum	red maple	2,4-D	methyl ester in kerosene, cut stump spray	36
		2,4,5-T	5% isopropyl ester	44
		Ammate	placed in holes in stem	36, 97
saccharinum	silver maple	2,4,5-T	esters, foliage spray	97
		D-T	mixed esters, foliage spray	80, 97
spicatum	mountain maple	D-T	mixed esters in oil, cut surface application	80, 97
Achillea millefolium	common yarrow	2,4-D	high concentration	75, 79
			Na salt, effective in spring and early summer	10
Aeschynomene virginica	curly-indigo or sensitive joint-vetch	2,4-D	smaller plants only	11, 20, 21, 98, 99
Aesculus octandra	yellow buckeye	D-T	mixed esters	13
Ageratum conyzoides	billy goat weed or tropic ageratum	2,4-D	Na salt, butyl ester, 2# per acre	73
		MCPA	Na salt, 2# per acre	73
Agropyron repens	quack grass or witch grass	2,4-D		38
		IPC	12-15# in 100 gal. oil per acre	47
		MH		107, 129, 130
		TCA		115
Agrostemma githago (Lychnis githago)	corn cockle or purple cockle	2,4-D	high concentration	75, 76
		MCPA	high concentration	76
Agrostis	bentgrass	IPC	8-10# in 100 gal. oil per acre	47
alba	redtop (grass)	2,4-D	ammonium salt	24
Alchemilla arvensis	ladys-mantle	DNOSBP		96

Scientific Name	Common name	Compound	Remarks	References
Alectorolophus (see *Rhinanthus*)				
Alisma	water-plantain	2,4-D		4, 30
Allium	wild onion	2,4-D	1½# per acre, ester	105
vineale	wild or field garlic	2,4-D	high concentration	57, 79, 94
			1½# per acre, ester	105
Alnus incana	speckled or gray alder	2,4-D	foliage spray	42, 57, 97
			methyl and ethyl esters, foliage spray	36, 37, 57
			ethyl and butyl esters, triethanolamine salt, cut branch application, two applications	82
		2,4,5-T	esters, foliage spray	37, 80
		Ammate	foliage spray	36, 97, 108
		DNOSBP	.05# per gal. in oil	97
		D-T	mixed esters, stump painting and foliage spray	43, 97
Alternanthera philoxeroides	alligator-weed	2,4-D		11, 17-21, 98
		2,4-D	8# per acre	62, 128
		2,4,5-T	less effective than 2,4-D	
Amaranthus graecizans	tumbleweed	2,4-D	1-2# per acre	87
retroflexus	pigweed or red-root or red-root pigweed or rough pigweed	2,4-D		48, 11, 17 28, 38, 85 87
			½# per acre, postemergence spray	104, 105
			1# per acre in soil, Na salt	117, 118
			Na salt, isopropyl ester	84, 86
			1½# per acre, butyl ester, pre-emergence	7
			Na salt	60, 76
		DNOCHP	in oil emulsion	102
		DNOSBP	ammonium salt	38, 74
			amine salt	1
			in oil emulsion	102
		MCPA		76
		TCA	Na and amine salt	116
spinosus (continued on next page)	spiny pigweed	2,4-D		4, 11, 17, 57, 83
		2,4-D	ammonium salt	24
			½# per acre, postemergence spray	104, 105

Scientific Name	Common name	Compound	Remarks	References
Amaranthus spinosus (continued)	spiny pigweed	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	73
Ambrosia	ragweed	2,4-D		38, 48, 52 57, 81, 100, 115
		Ammate		52
		DNOSBP	ammonium salt	38, 115
		PCP	Na salt in oil	115
artemisiifolia	common or dwarf or lesser ragweed	2,4-D		11, 17, 39, 52, 85
		2,4-D	1½# in 100 gal. water per acre	54
			½# per acre, postemergence spray	104, 105
		Ammate		52
elatior (*artemisiifolia elatior*)	common ragweed	2,4-D	2# per acre	28
psilostachya	perennial or western ragweed	2,4-D		52
		2,4-D	1¼# in 100 gal. water per acre	54
			½# per acre, postemergence spray	105
		Ammate		52
trifida	great or giant ragweed	2,4-D		11, 17, 39, 52
		2,4-D	1¼# in 100 gal. water per acre	54
			½# per acre, postemergence spray	105
		Ammate		52
Amelanchier alnifolia	Juneberry or shadbush or serviceberry	2,4-D	methyl ester in kerosene, foliage spray	36
		2,4,5-T	esters, foliage spray	97
			ester in oil, basal stem application	80
		Ammate	foliage spray	36, 97
		D-T	mixed esters, foliage spray	97
oblongifolia	Juneberry or shadbush or serviceberry	2,4-D	foliage spray	57
		D-T	mixed esters, stump painting, foliage spray	43
Ammannia coccinea	toothcups or red-stem	2,4-D		11, 17, 98
Ampelopsis arborea	pepper-vine	2,4-D		11, 17

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
Amsinckia intermedia	tarweed or fiddle-neck	2,4-D	salts, ester	30
Anagallis arvensis	(scarlet) pimpernel	2,4-D		75
		MCPA	postemergence application	109, 110
Anaphalis margaritacea	pearly everlasting	D-T	mixed esters, foliage spray	43
Anthemis arvensis	corn chamomile or field camomile	2,4-D MCPA	high concentration, Na salt	76
cotula	dog-fennel or mayweed	2,4-D	ammonium salt high concentration	24 57
Anthoxanthum odoratum	sweet vernal grass	IPC	4-6# per acre to seedlings	47
Anthriscus sylvestris	wild chervil	2,4-D	high concentration	75
		MCPA	Na salt, 2# per acre	58
Apocynum androsaemifolium	spreading dogbane	2,4-D	foliage spray	42
		Borax		122
Arctium	burdock	2,4-D	Na and alkanolamine salts, isopropyl ester, foliage spray	56, 57
		2,4,5-T	isopropyl ester, foliage spray	56
Arctostaphylos uva-ursi	bearberry	2,4-D D-T	esters mixed esters foliage spray	97
Argemone mexicana	prickly-poppy	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Aronia	chokeberry	Ammate	foliage spray	97
Artemisia absinthium	common wormwood	2,4-D	high concentration	57
campestris	wormwood	2,4-D		75
filifolia	sand sagebrush	2,4-D	salt, amine, ester 1# per acre	126 50
tridentata	big sagebrush	2,4-D	butyl ester	65
vulgaris	common mugwort	2,4-D		75
		2,4-D	Na salt	76
		MCPA		76
Asclepias syriaca	milkweed	2,4,5-T D-T	esters mixed esters 35% sol., stem painting	44
Atriplex patula	orach or fat-hen saltbush	DNOC		15
		DNOSBP		96
Avena fatua	wild oat	IPC	5-8# per acre in soil prior to germination	47

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
Axonopus compressus	carpet grass or savannah grass	2,4-D		11, 17
		2,4-D	Na and triethanolamine salts	68
Baccharis pilularis	coyote brush	2,4-D	ester	30
Barbarea verna	early-cress or early winter-cress	2,4-D		79
vulgaris	winter-cress			
Bellis perennis	English daisy	2,4-D	high concentration	75
		MCPA	Na salt, 2# per acre	58
Benzoin aestivale (see *Lindera benzoin*)				
Berberis fendleri	(native) Colorado barberry	2,4-D	ester, foliage spray	80
		D-T	mixed esters in oil, dormant spray	
Berteroa incana	hoary-alyssum	2,4-D	high concentration	57
Betula	birch	2,4-D	esters, two applications	82
		2,4-D	esters, foliage spray	37
		2,4,5-T		
		D-T	mixed esters, dormant spray	80
alba	paper birch	2,4-D	effective seedling kill	42, 43
		D-T	wood painting effective on 8-ft. trees	43
lenta	black or sweet or cherry birch	2,4-D	effective seedling kill	42
		D-T		43
lutea	yellow birch	2,4-D	effective seedling kill	42
		D-T	triethanolamine salt, stump painting	43
nigra	river birch	D-T	mixed esters, foliage spray	80
populifolia	gray birch	2,4-D	effective seedling kill, wood painting effective on older trees	42
		D-T	mixed esters, foliage spray	43
Bidens				
frondosa	beggars-ticks	2,4-D		57
pilosa	beggars-ticks	2,4-D	Na salt, butyl ester, #1 per acre	73
		MCPA	Na salt, 1# per acre	
Boerhaavia diffusa	hogweed or hogmeat or spiderling	2,4-D	Na salt, butyl ester, 2# per acre	73
		MCPA	Na salt, 2# per acre	

Scientific Name	Common name	Compound	Remarks	References
Brassica kaber (*arvensis*) (see also *B. sinapis* and *Sinapis arvensis*)	charlock or wild mustard	2,4-D		4, 33
		2,4-D	½# per acre, postemergence spray	104, 105
		DNOSBP	ammonium salt, aqueous spray	38
sinapis	yellow charlock	2,4-D MCPA		111
Bromus	annual brome grass	IPC	3-5# per acre to seedlings	47
rigidus	ripgut or ripgut brome grass	IPC		30
secalinus	chess or cheat (grass)	IPC		31, 47
		IPC	3-5# per acre to seedlings	47
tectorum	downy brome grass	2,4-D	2# per acre	28
		LPOF		53
Bursaria spinosa	blackthorn	2,4,5-T	ester, foliage spray, two treatments	51
Caesulia axillaris		2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Cailliea glomerata (*Dichrostachys nutans*)	aroma or aroma marabu	2,4-D	Na salt, ester	114
Caperonia castaneaefolia	bird-eye or Mexican-weed	2,4-D		11, 20, 21, 98, 99
Capsella bursa-pastoris	shepherds-purse	2,4-D	high concentration	75
			Na salt ———	76
			Na salt 4# per acre in soil	117
		DNOC	Na salt	30
		DNOSBP	ammonium salt	74
		MCPA		76
Cardaria draba (*Lepidium draba*)	hoary-cress	2,4-D		46
		2,4-D	Na salt, high concentration	76
		2,4,5-T		46
		MCPA	high concentration	76
Carpinus virginiana (see *Ostrya*)				
Carya	hickory	Ammate	crystals in frills on trunk	25, 64
			crystals in cups at base of trunk	90, 92
		D-T	mixed esters, foliage spray	80

Scientific Name	Common name	Compound	Remarks	References
Carya aquatica	bitter pecan	Ammate	crystals in cups at base of trunk	23, 77, 90, 92
		Na arsenite	POISONOUS	23, 64, 77, 90, 92
cordiformis	bitternut (hickory)	D-T	mixed esters in oil, dormant spray	80
ovata	shagbark or shellbark hickory	2,4,5-T	esters in oil, dormant spray	80
		Ammate	foliage spray	97
Castanea dentata	American chestnut	D-T	mixed esters foliage spray mixed esters in oil, dormant spray	43 80
Catalpa bignonioides	common catalpa	D-T	mixed esters, foliage spray	80
Celosia argentea	quail-grass or feather cockscomb	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Celtis occidentalis	hackberry	2,4-D	esters, foliage and cut surface sprays	97
Centaurea calcitrapa	star-thistle	2,4-D		120
cyanus	cornflower or French-pink or bachelors-button	2,4-D	high concentration Na salt	75 4, 76
		DNOC	ammonium salt	14
		MCPA		76
nigra	knapweed	MCPA	Na salt, 4# per acre	58
solstitialis	yellow star-thistle	2,4-D		4
		DNOC	Na salt	30
Cephalanthus occidentalis	button-bush or button-willow	2,4-D 2,4,5-T	ester	30
Cerastium vulgatum	common mouse-ear chickweed	MCPA	postemergence application	109, 110
Chenopodium	smooth pigweed	2,4-D		57, 75
		2,4-D	ammonium salt ½# per acre, postemergence spray	24 104, 105
album (continued on next page)	lambs-quarters or fat-hen or goosefoot	2,4-D		4, 38, 49, 57, 85
		2,4-D	1# per acre, postemergence spray Na salt ———— Na salt 4# per acre in soil	104, 105 60, 76 117
		DNOCHP	in oil emulsion	102
		DNOSBP		96

Scientific Name	Common name	Compound	Remarks	References
Chenopodium album (continued)	lambs-quarters or fat-hen or goosefoot	DNOSBP	ammonium salt	30, 38, 74
			amine salt	1
			in oil emulsion	102
		EH-1		72
		MCPA		76
		MCPA	Na salt as dust	109
bonus-henricus	good King Henry	2,4-D	Na salt	76
		MCPA		76
botrys	Jerusalem-oak	2,4-D	ammonium salt	24
paganum	pigweed	2,4-D	1# per acre, postemergence spray	104, 105
		DNOSBP	ammonium salt	30
Chrysanthemum leucanthemum	ox-eye daisy	2,4-D	high concentration	75, 79
		MCPA	high concentration on young plants	58
segetum	corn-marigold	2,4-D	high concentration	75
		MCPA	postemergence application	109, 110
Cichorium intybus	common chicory	2,4-D	high concentration	30, 57
			½# per acre, postemergence spray	105
Cicuta maculata	water-hemlock	2,4-D		49
		2,4-D	high concentration	57
			Na salt	76
		D-T	mixed esters	13
		MCPA		76
Cirsium arvense	Canada or creeping thistle	2,4-D		49, 75, 124
		2,4-D	Na salt	76
			ester, foliage spray	57
			foliage spray	4, 42, 56
			1# per acre, postemergence spray	104, 105
			Na salt, effective in spring and early summer	10
		D-T	mixed esters, foliage spray	43, 56
		MCPA		58, 76
		MCPA	Na salt as dust	109
lanceolatum	bull thistle	2,4-D	foliage spray in early spring	42, 56
			Na salt	76
		D-T	mixed esters, foliage spray	43, 56
		MCPA		76
pumilum	pasture or bull thistle	D-T	mixed esters, foliage spray	43

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
Cirsium vulgare	bull or spear thistle	MCPA	Na salt, 2# per acre	58
Clematis virginiana	virgin's bower	D-T	mixed esters, foliage spray	43
Colchicum autumnale	autumn-crocus	2,4-D	high concentration	75
Commelina	day-flower or bat-wing or turtle-back	2,4-D		11, 17, 20 98
benghalensis	day-flower or tropical spider-wort	2,4-D	Na salt, butyl ester, 2# per acre	73
		MCPA	Na salt, 2# per acre	
longicaulis	cohitre	2,4-D		83
nudiflora (*diffusa*)	day-flower or French-grass or French-weed	2,4-D	sodium and triethanolamine salts	22, 68
Comocladia dentata	guao	2,4-D	ester	114
Comptonia peregrina	sweet-fern	2,4-D	esters, foliage spray	80, 97
		Ammate	foliage spray	97
Condalia obtusifolia	lote or lotewood or blue-brush	2,4-D	ester in oil	126
		2,4,5-T	ester in oil	80, 126
Conium maculatum	poison-hemlock	2,4-D 2,4,5-T		45
Convolvulus	bindweed	2,4-D		8
		2,4-D	esters, foliage spray, high concentration	57
			1# per acre, postemergence spray	104, 105
arvensis	bindweed	2,4-D		4, 49, 106, 124
sepium	hedge bindweed or wild morning-glory	2,4-D		75, 124
		2,4-D	½# per acre, postemergence spray	104, 105
Corchorus trilocularis	corchorus or Jews-mallow	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Cornus florida	flowering dogwood	2,4,5-T	esters in oil, basal stem application, 1% sol.	80
Corylus americana	American hazelnut or American filbert	2,4-D	foliage spray	80
		Ammate	foliage spray	97, 127
cornuta (*rostrata*) (continued on next page)	beaked hazelnut or beaked filbert	2,4-D	ethyl, methyl, and isopropyl esters; foliage spray	36, 37, 57
		2,4,5-T	esters, foliage spray	37

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
Corylus cornuta (continued)	beaked hazelnut or beaked filbert	Ammate	foliage spray	36, 97, 127
		D-T	mixed esters, foliage spray	43
Crataegus	hawthorn	2,4-D	foliage spray	42
			methyl and ethyl esters, foliage spray	36
		2,4,5-T	esters, foliage spray	37
		Ammate	foliage spray	36
		DNOSBP	in kerosene, stem spray	36
		D-T	mixed esters, foliage spray	80, 97
Crepis virens	hawks-beard	2,4-D	high concentration	75
Crotalaria striata (*mucronata*)	rattle-box	2,4-D	8# per acre, pre-emergence spray	70
Cuscuta	dodder	2,4-D		11
		2,4-D	1# per acre	105
Cynodon dactylon	Bermuda grass	2,4-D	ester in diesel oil	83
Cyperus				
articulatus	wild-onion	2,4-D		98
esculentus	chufa or yellow nut-grass	2,4-D		2, 4
		MCPA		2
iria	yellow sedge	2,4-D		11, 17, 20, 98
rotundus	nut-grass or coco-grass	2,4-D		11, 17
		2,4-D	ammonium salt	24, 40
			butyl ester	40
			Na salt, butyl ester, 2# per acre	73
			ester in diesel oil	83
		2,4,5-T	butyl ester	40
		MCPA	Na salt, 2# per acre	73
		MH	0.5%	129, 130
strigosus	sedge	2,4-D		30
Datura	jimson-weed or thorn-apple	2,4,5-T		6
fastuosa (*metel*)	thorn-apple	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
stramonium	jimson-weed or thorn-apple or stramonium	2,4-D		30
		2,4-D	1# per acre, postemergence spray	73, 104
		MCPA	1# per acre, Na salt	73
Daucus carota (continued on next page)	wild carrot	2,4-D		75
		2,4-D	high concentration	4, 57
			1# per acre, postemergence spray	104

No.	Scientific Name	Common name	Compound	Remarks	References
12	*Daucus carota* (continued)	wild carrot	2,4-D	Na salt	76
			MCPA		76
			MCPA	Na salt, 2# per acre	58
	Dichrostachys nutans (see *Caillica glomerata*)				
	Diervilla lonicera	(dwarf) bush-honeysuckle	Ammate	foliage spray	63, 97
			EH-1		72
	Digitaria sanguinalis	rough or hairy crab grass	2,4-D		8
			2,4-D	ester in diesel oil	83
				isopropyl ester	103
				ammonium salt	24
				8# per acre, pre-emergence spray	70
			DNOSAP		103
			DNOSBP	amine salt	1
			IPC	at germination	47
			LPOF		53, 55
			MH	0.25% on young plants	129, 130
			Na arsenite	POISONOUS	71, 123
			TCA		115
	Diodia virginiana	buttonweed	2,4-D	isopropyl ester	103
			DNOSAP		103
	Diospyros virginiana	common persimmon	Ammate	crystals in frills on trunk	64
				crystals in cups at base of trunk	25, 90, 92
	Diplotaxis tenuifolia	wall-rocket	2,4-D	high concentration	75
	Duchesnea indica	Indian-strawberry	2,4-D		79
	Echinochloa crusgalli	barnyard grass	2,4-D		38
		water grass or barnyard grass	IPC	must be present at time of germination	47
			MH		31, 32
	Echium vulgare	blue-weed or blue-devil or vipers-bugloss	2,4-D	Na salt, high concentration	76
			MCPA	high concentration	
	Eclipta alba	false-daisy or yerba-de-Tajo	2,4-D	Na salt, butyl ester, 1# per acre	73
			MCPA	Na salt, 1# per acre	
	Eichhornia crassipes	water-hyacinth	2,4-D		17, 21, 98
			2,4-D	sodium and triethanolamine salts	22, 68
				8# per acre	62, 130
			2,4,5-T	less effective than 2,4-D	62, 130
			MCPA		68

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENC
Eleusine indica	goose grass or wire grass	2,4-D		2
		2,4-D	8# per acre, pre-emergence spray	70
			ester in diesel oil	83
			ammonium salt	24
		MCPA		2
Equisetum	horsetail	2,4-D	1# per acre, repeated treatments	105
		MCPA	Na salt, 4# per acre	58
arvense	field horsetail	2,4-D	high concentration	75
palustre	marsh horsetail	2,4-D	high concentration	75
Eragrostis	love grass	TCA		115
megastachya	stink grass	2,4-D	1½# per acre, butyl ester, pre-emergence	7
pilosa	purple or India love grass			
Erigeron				
annuus	daisy fleabane	2,4-D	high concentration	57
canadensis	horse-weed	2,4-D		57, 75
		2,4-D	½# per acre, postemergence spray	104
philadelphicus	(daisy) fleabane	2,4-D		17
Eriochloa polystachya	cup grass	2,4-D	ester in diesel oil	83
Erodium moschatum	herons-bill or storks-bill	2,4-D MCPA	seedlings only	88
Eupatorium rugosum	white snakeroot	D-T	mixed esters	13
Euphorbia	spurge	2,4-D		8
		2,4-D	salts, ester	30
dentata (Poinsettia dentata)	milkweed or poinsettia or toothed euphorbia or toothed spurge	2,4-D		11, 17
esula	leafy spurge	borax		122
geniculata	spurge	2,4-D	Na salt, butyl ester, 1# per acre	73
thymifolia	spurge	MCPA	Na salt, 1# per acre	
pilulifera	asthma-plant or pillpod spurge	2,4-D	Na salt, butyl ester, 2# per acre	73
		MCPA	Na salt, 2# per acre	
Fagus	beech	Ammate	crystals in frills on trunk	64
			crystals in cups at base of trunk	92
Festuca	rat-tail fescue	IPC	4-6# per acre to seedlings	47

ientific Name	Common name	Compound	Remarks	References
imbristylis miliacea	fimbristylis	2,4-D		98
raxinus	ash	Ammate	crystals in frills on trunk crystals in cups at base of trunk	64 25, 90, 92
		D-T	mixed esters in oil, applied to cut surfaces	80
pennsylvanica lanceolata	green ash	Ammate	foliage spray	97
		D-T	mixed esters, foliage spray	
umaria officinalis	earth-smoke or fumitory	2,4-D	high concentration	75
		DNOC	ammonium salt, seedlings	14
		MCPA	Na salt, seedlings	
aleopsis ladanum	hemp-nettle	2,4-D	high concentration	75
tetrahit	hemp-nettle	DNOC	ammonium salt	15
		D-T	mixed esters, foliage spray	43
		MCPA	Na salt	15
alinsoga ciliata	galinsoga	2,4-D	foliage spray	93
		DNOSBP	ammonium salt	74
parviflora	galinsoga	2,4-D		75
alium aparine	cleavers	2,4-D MCPA	1# per acre in soil	112
		IPC	5# per acre in soil	
		IPC-2,4-D IPC-MCPA	better than either alone	
		DNOSBP	under 2 cm. high	96
aultheria procumbens	wintergreen	D-T	mixed esters, foliage spray	43
elsemium sempervirens	Carolina (yellow) jessamine	D-T	mixed esters	13
eranium molle	cranesbill	2,4-D	high concentration	57
lechoma hederacea (Nepeta hederacea)	ground-ivy or gill-over-the-ground or run-away-robin	2,4-D	high concentration	75
leditsia triacanthos	honey-locust	2,4,5-T		71
		D-T	mixed esters, foliage spray	80
leichenia linearis	resam (fern)	Na arsenite	foliage spray POISONOUS	22

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENC
Glottidium vesicarium	bladder-pod or bag-pod or old-fashion coffee-bean	2,4-D		98
Grindelia squarrosa	gumweed or gum-plant	2,4-D		57
Halogeton glomeratus	barilla	2,4-D		5
Hamamelis virginiana	witch-hazel	D-T	mixed esters, foliage spray	43
Helianthus annuus	wild or common sunflower	2,4-D	½# per acre, postemergence spray	105
tuberosus	Jerusalem artichoke			
Heteranthera limosa	mule-ear or mud-plantain	2,4-D		11, 17, 20,
Hibiscus trionum	flower-of-an-hour	2,4-D	½# per acre, postemergence spray	104, 105
Hieracium aurantiacum	orange hawkweed or devils paint-brush	2,4-D	fully grown plants resistant	54
		MCPA	Na salt on young plants	58
canadense	hawkweed	D-T	mixed esters, foliage spray, young plants only	43
		MCPA	Na salt on young plants	58
floribundum	hawkweed or king devil	2,4-D	high concentration	57
Holcus halepensis (see *Sorghum halepense*)				
lanatus	velvet grass	IPC	5-8# per acre to seedlings	47
Hydrocotyle umbellata	(water) pennywort or dollar-grass	2,4-D		11, 17
Hypericum perforatum	St. Johns-wort	2,4-D	foliage spray	42
			high concentration	57
		D-T	mixed esters, foliage spray	43
Hypochoeris radicata	cats-ear	2,4-D		4
		MCPA	Na salt, 4# per acre	58
Ilex verticillata	winterberry	D-T	mixed esters, foliage spray	43
vomitoria	yaupon	2,4-D		11, 17
		2,4-D	ester in oil	126

CIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
digofera glandulosa	indigo	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
omoea				
calobra	weir vine	2,4-D		121
muricata	morning-glory	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
pandurata	wild sweet-potato	2,4-D	1# per acre, postemergence spray	104, 105
purpurea	common morning-glory	2,4-D		30
		2,4-D	½# per acre, postemergence spray	104, 105
		DNOSBP	ammonium salt	30
a ciliata	rough-leaved marsh-elder	2,4-D		11, 17
acquemontia (Thyella) tamnifolia	tievine	2,4-D		11, 17
uglans nigra	black walnut	2,4-D	foliage spray	57
uncus	rush	MCPA	Na salt, 2# per acre	58
uniperus communis depressa	low or ground juniper	2,4,5-T	5% isopropyl ester	44
ussiaea	water-primrose or primrose-willow	2,4-D		98
linifolia	water-primrose	2,4-D	Na and triethanolamine salts	22
repens	clove-strip			
suffruticosa	West Indian loosestrife	2,4-D	Na and triethanolamine salts	22, 68
almia angustifolia	sheep-laurel or lambkill (kalmia)	2,4-D	foliage spray	42
		D-T	mixed esters, foliage spray	13, 43
latifolia	mountain-laurel	D-T	mixed esters, spray, 5% sol.	13, 44
actuca	wild lettuce	2,4-D		85
virosa (scariola)	prickly lettuce	2,4-D		75
agascea mollis		2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
amium	dead-nettle	2,4-D	high concentration	75
amplexicaule	henbit	2,4-D	1-2# per acre	87
		DNOSAP		34

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
Lantana camara	lantana	2,4,5-T	ester, foliage spray, two treatments	51
Lathyrus aphaca	yellow-vetch	2,4-D	Na salt, high concentration	76
		MCPA	postemergence application	109, 110
			high concentration	76
Legousia hybrida (see *Specularia*)				
Leontodon	hawkbit	MCPA	Na salt, 2# per acre	58
Lepidium				
draba (see *Cardaria*)				
virginicum	pepper-grass	2,4-D	½# per acre, postemergence spray	105
Leptospermum	tea-tree	2,4,5-T	ester, foliage spray	51
Leucas aspera		2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Limnocharis flava	yellow velvet-leaf	2,4-D	Na and triethanolamine salts	22, 68
Linaria vulgaris	butter-and-eggs	2,4-D	high concentration	75
		D-T	mixed esters, foliage spray	43
Lindera benzoin (*Benzoin aestivale*)	spicebush	2,4-D	esters, foliage spray	80
Liquidambar styraciflua	sweet gum	Ammate	foliage spray, sprouts	26
		Ammate	crystals on trunk in cups at base	26, 90, 92
			crystals on trunk in frills	26, 64
		2,4,5-T	esters in oil and water	80
Liriodendron tulipifera	tulip-tree or tulip-poplar or yellow-poplar	2,4-D		66, 67
		D-T	mixed esters dormant spray in oil or foliage spray	80
Lolium	rye grass	IPC	4-6# per acre to seedlings	47
Lonicera	wild honeysuckle	D-T	mixed esters, foliage spray	80
japonica	Japanese honeysuckle	2,4-D		119
		2,4-D	1% at 150-200 gal. per acre	61
		Borax	10# per sq. rod	119
		D-T	mixed esters, foliage spray	80

CIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
ychnis				
dioica (*Melandrium rubrum*)	red campion	2,4-D		75
githago (see *Agrostemma*)				
ycopodium complanatum flabelliforme	ground-cedar or ground-pine	D-T	mixed esters, spray during cold dormant season, 5% sol.	44
yonia ligustrina	male-berry	D-T	mixed esters, foliage spray	43
ysimachia nummularia	moneywort	2,4-D	high concentration	57
aclura pomifera	Osage-orange	2,4,5-T	foliage spray	57, 71
			ester in oil, cut surface application, 5% sol.	80
agnolia				
australis	southern sweet bay	Ammate	crystals in frills on trunk	64
			crystals in cups at base of trunk	25, 90
virginiana	sweet bay	Ammate	crystals in cups	80
aianthemum canadense	wild or false lily-of-the-valley	D-T	mixed esters, foliage spray	43
alus coronaria	American or wild sweet crab apple	D-T	mixed esters, foliage spray	97
ioensis (*Pyrus ioensis*)	wild or prairie crab apple	D-T	mixed esters in oil, on cut surfaces	80
			mixed esters foliage spray	97
alva	mallow	MCPA	Na salt, 2# per acre	58
atricaria	mayweed or wild chamomile	DNOSBP		96
chamomilla	mayweed or German camomile or sweet false chamomile	2,4-D	Na salt, high concentration	76
		DNOC	Ammonium salt	14
		DNOSBP		96
		MCPA	high concentration	76
inodora	scentless mayweed	2,4-D	Na salt, high concentration	76
			butyl ester	113
			high concentration	75
		MCPA	butyl ester	113
			Na salt as dust	109
			high concentration	76
edicago hispida	bur-clover	2,4-D	Na salt	76
		MCPA		76

Scientific Name	Common name	Compound	Remarks	References
Melandrium rubrum (see *Lychnis dioica*)				
Melochia corchorifolia	redweed	2,4-D		11, 17, 20, 9
Mercurialis annua	boys-and-girls or herb-mercury	2,4-D	high concentration	75
Mimosa pudica	sensitive plant	MCPA		68
Mirabilis jalapa	four-o'clock	2,4-D	Na salt, butyl ester, 2# per acre	73
		MCPA	Na salt, 2# per acre	
Monochoria hastaefolia		2,4-D	Na and triethanolamine salts	22, 68
vaginalis		2,4-D	Na and triethanolamine salts	22
Musa cavendishi	dwarf banana	2,4-D MCPA	ethylester or acid Na salt injection into pseudo-stem	69
Myrica cerifera	wax-myrtle	2,4-D	ester in oil, cut surface application, 5% sol.	80
		2,4,5-T	esters in oil 1% sol. on base of stem 2½% sol. on cut surface	
Nepeta hederacea (see *Glechoma*)				
Nicandra physalodes	apple-of-Peru	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Nyssa sylvatica	black or sour gum or pepperidge	2,4-D 2,4,5-T	5% sol. 2½% sol. ester in oil, cut surface application	80
		Ammate	crystals in cups at base of trunk	25, 80, 90, 9
Oakesia sessilifolia (see *Uvularia*)				
Ocimum canum	hoary basil	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Oenothera	evening-primrose	2,4-D	high concentration	57
Onopordum acanthium	cotton-thistle or Scotch-thistle	MCPA	Na salt, 2# per acre	58

CIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
puntia	prickly-pear (cactus)			
humifusa	prickly-pear	2,4,5-T	ester in oil, foliage spray	80
imbricata	cholla cactus	2,4,5-T	ester in oil	126
leptocaulis	Tasajillo cactus			
lindheimeri	Lindheimer prickly-pear			
strya virginiana	ironwood or American hop-hornbeam	2,4,5-T	esters in oil, basal stem application, 1% sol.	80
		Ammate	crystals in cups at base of trunk	92
		D-T	mixed esters, foliage spray, small plants and suckering stumps killed	43
xalis cernua	yellow-sorrel or Bermuda-buttercup	2,4-D MCPA	seedlings only	88
anicum capillare	tickle grass or common witch grass	2,4-D	1½# per acre, butyl ester, pre-emergence	7
			Na salt	60, 117
		IPC	6-8# per acre in soil prior to germination	47
		LPOF		53
sanguinale	panic or pigeon grass	LPOF		53
apaver rhoeas	field or corn poppy	2,4-D		49
		2,4-D	Na salt	76
			butyl ester	113
		DNOC	ammonium salt, seedlings	14
		DNOSBP		96
		MCPA		76
		MCPA	butyl ester	113
			Na salt on seedlings	14
			as dust	109
arthenocissus quinquefolia (*Psedera quinquefolia*)	woodbine or Virginia creeper	2,4-D	esters on cut surfaces	97
		D-T	mixed esters, foliage spray	43
halaris	canary grass	IPC	12-15# in 100 gal. oil per acre	47
hyllanthus urinaria	leaf-flower or seaside-laurel	2,4-D	sodium and triethanolamine salts	68
			Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCE
Picea abies	Norway spruce	2,4-D	seedlings susceptible to foliage spray	42
		D-T	mixed esters, seedlings susceptible to foliage spray	43
Pinus ponderosa	ponderosa pine or western yellow pine	Ammate	10# per gal. water in holes in stem	59
strobus	white pine	2,4-D	seedlings up to 3 ft. in height susceptible to foliage spray	43
		2,4,5-T	isopropyl ester 5%	44
		D-T	mixture esters, foliage spray	42
Plantago lanceolata	buckhorn (plantain) or narrow-leaved or English plantain or rib-grass	2,4-D		4, 30, 49, 5 57, 71, 75 78, 79, 12
		MCPA	Na salt, 2# per acre	58
major	common or broad-leaved plantain	2,4-D		71, 75, 79, 123
		DNOCHP DNOSBP	in oil emulsion	102
		MCPA	Na salt, 2# per acre	58
media	hoary or sweet plantain	2,4-D		49, 71, 75
Platanus occidentalis	buttonwood or American sycamore or American plane-tree	D-T	mixed esters, foliage spray	80
Poinsettia dentata (see *Euphorbia dentata*)				
Polygonum	smartweed or knotweed	2,4-D		38, 75, 115
		2,4-D	½# per acre, postemergence spray	104, 105
		DNOSBP	ammonium salt	115
		IPC	5# per acre	112
		PCP	Na salt in oil	115
		TCA		115
amphibium	amphibious bistort or water smartweed	2,4-D MCPA	butyl ester	113
aviculare (continued on next page)	knotweed or knot-grass	2,4-D	Na salt, high concentration	76
			butyl ester	113
		IPC	6-8# per acre	47

cientific Name	Common name	Compound	Remarks	References
'olygonum aviculare (continued)	knotweed or knot-grass	MCPA	high concentration butyl ester	76 113
coccinium	kelp or smartweed	2,4-D		4, 30
convolvulus	black bindweed or wild-buckwheat	2,4-D	1# per acre, postemergence spray Na salt, high concentration butyl ester	105 15, 76 113
		DNOC	ammonium salt	15
		MCPA	butyl ester high concentration postemergence application, resistant to dust	113 15, 76 109, 110
hydropiper	common smartweed	DNOSBP	ammonium salt	30, 74
persicaria	lady's-thumb	2,4-D	Na salt, high concentration	76
		MCPA	high concentration	
Populus balsamifera	balsam poplar	D-T	mixed esters, foliage spray	97
deltoides	cottonwood	2,4-D	ester, foliage spray	30, 97
		Ammate	applied to cut stump	97
		D-T	mixed esters, foliage spray	97
grandidentata	big-tooth or large-toothed aspen	2,4-D	foliage spray acid ethyl ester	42 36
		Ammate	foliage spray	36
		DNOSBP	in kerosene, stem spray	36
		D-T	mixed esters, foliage spray	43
sargenti	cottonwood	2,4-D	ester in oil 5% sol. on base of stem	80
		D-T	mixed esters in oil	
tacamahaca	balsam poplar or tacamahac	2,4-D	methyl and ethyl esters, foliage spray	36
tremuloides	quaking or trembling aspen	2,4-D	esters, two applications methyl ester in kerosene, foliage spray	82 36, 37
		2,4,5-T	esters foliage spray in oil, basal stem application	37, 97 80
		Ammate	foliage spray	36, 63
		DNOSBP	in kerosene, stem spray	35, 36
		D-T	mixed esters foliage spray in oil, on base of stem	97 80

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCE
Portulaca oleracea	purslane	2,4-D		85
		2,4-D	ammonium salt	24
			4# per acre in soil	117, 118
			Na salt isopropyl ester	60, 84, 86
			butyl ester, 1# per acre	73
			butyl ester, 1½# per acre, pre-emergence	7
		DNOSBP	ammonium salt	74
		EH-1		72
		IPC	4-6# per acre	47
		MCPA	Na salt, 1# per acre	73
Potentilla anserina	silver-weed	MCPA	Na salt, 4# per acre	58
arguta	tall cinquefoil	D-T	mixed esters, foliage spray	43
canadensis	cinquefoil or five-finger	2,4-D	foliage spray	42
fruticosa	shrubby cinquefoil or golden-hardhack	D-T	mixed esters, foliage spray	43
Prosopis juliflora glandulosa	mesquite	2,4,5-T	ester in oil-water emulsion, foliage spray	71, 126
			young plants	16
Prunella vulgaris	heal-all or self-heal	2,4-D	high concentration	57
Prunus americana	wild or American plum	2,4-D	esters, foliage spray	97
		D-T	mixed esters, foliage spray	
avium	sweet cherry	D-T	mixed esters, foliage spray	80
nigra	Canada plum	2,4,5-T	esters, foliage spray	97
pennsylvanica	fire cherry or pin cherry or wild red cherry	2,4-D	foliage spray, acid	42
			foliage spray, methyl ester	36
		2,4,5-T	esters, foliage spray	97
			esters in oil, basal spray	80
		Ammate	foliage spray	36
		D-T	mixed esters, foliage spray	43, 80, 97
persica	peach	2,4-D	foliage spray	57
serotina (continued on next page)	black or wild black cherry	2,4-D	foliage spray	42, 66, 67, 80, 97
		2,4,5-T	esters, foliage spray	97

cientific Name	Common name	Compound	Remarks	References
runus serotina (continued)	black or wild black cherry	Ammate	foliage spray	63, 97
		D-T	mixed esters, foliage spray	13, 43, 80, 97
virginiana	choke cherry	2,4-D	foliage spray acid	42
			foliage spray methyl ester in kerosene	36, 37
			isopropyl ester in fuel oil	36, 37
		2,4,5-T	esters, foliage spray	37, 97
		Ammate	foliage spray	97
		D-T	mixed esters, foliage spray	13, 43, 80
sedera quinquefolia (see *Parthenocissus*)				
soralea corylifolia	bawchee seed plant or scurfy-pea	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
teridium aquilinum	bracken (fern)	Ammate	foliage spray	63, 97
ueraria thunbergiana	kudzu vine	D-T	mixed esters, foliage sprays	80
yrus communis	pear	2,4-D	foliage spray	57
ioensis (see *Malus ioensis*)				
uercus alba	white oak	2,4,5-T	foliage spray	80, 97
		Ammate	cut surface	97
		Ammate	crystals on trunk in cups at base	92
			crystals on trunk in frills	64
		D-T	mixed esters, foliage spray	97
borealis	northern red oak	D-T	mixed esters, foliage spray	97
coccinea	scarlet oak	D-T	mixed esters, foliage spray	80, 97
cinerea *laevis*	bluejack oak turkey oak	Ammate	crystals in cups at base of trunk	25, 26, 92
marilandica	blackjack oak	2,4-D	isopropyl ester in frills on trunk	91
		2,4,5-T	ester in oil foliage spray	126
			ester in oil cut surface application, 3% sol.	80
		Ammate	crystals on trunk in frills	64
			crystals on trunk in cups at base	23, 25, 26, 89-92

Scientific Name	Common name	Compound	Remarks	References
Quercus montana	chestnut oak	D-T	mixed esters, foliage spray	80
nigra	water oak	2,4,5-T	esters in oil, dormant spray, 20% sol.	80
phellos	willow oak	Ammate	crystals in cups at base of trunk	25, 90
rubra (see also *Q. borealis*)	red oak			
stellata	post oak	2,4,5-T	ester in oil, foliage spray	126
			ester in cut surface frills, 1% sol.	80
		Ammate	crystals in cups at base of trunk	25, 26, 90, 9
		D-T	mixed esters, foliage spray	80
stellata margaretta	dwarf post oak	Ammate	crystals in cups at base of trunk	25, 26, 92
virginiana	live oak	2,4,5-T	esters in cut surface frills, 1% sol.	80
Ranunculus	buttercup	2,4-D		49, 75
		2,4-D	Na salt ½# per acre postemergence spray	76 105
		MCPA	Na salt, 2# per acre postemergence application	58 109, 110
acris	tall buttercup	2,4-D	Na salt	49, 76
		MCPA		76
arvensis	corn buttercup	2,4-D		75
		2,4-D	Na salt	14, 76
		MCPA		76
		MCPA	Na salt	14
repens	creeping buttercup	2,4-D		49
		2,4-D	Na salt high concentration	76
		MCPA	acid high concentration	
Raphanus raphanistrum	white or jointed charlock or wild radish	2,4-D		75, 88
		DNOC	ammonium salt	15
		DNOSBP		96
		MCPA		76, 88
		MCPA	postemergence application, spray more effective than dust	109, 110
Rhinanthus (*Alectorolophus*)	yellow-rattle	2,4-D	high concentration	75
		MCPA	Na salt, 4# per acre	58
Rhus aromatica	fragrant sumac	2,4-D	ester, foliage spray	80

ientific Name	Common name	Compound	Remarks	References
hus glabra	smooth sumac	2,4-D D-T	esters mixed esters } foliage spray	30, 97
		Ammate 2,4,5-T	salt esters } foliage spray	97
radicans (*toxicodendron*)	poison-ivy or poison-oak	2,4-D		11, 17, 39, 97, 119
		2,4-D	ester	30
			aqueous foliage spray	52, 54
		2,4,5-T	foliage spray esters	37, 71, 97
			foliage spray aqueous	54, 71, 97
		Ammate	1½# dry per sq. rod	119
			aqueous foliage spray	52, 54, 71, 97, 122
		Borax		119
		D-T	mixed esters, foliage spray	43, 80, 97
typhina	staghorn sumac	2,4-D	foliage spray acid	37, 42, 97
			foliage spray esters	57, 80, 97
		2,4,5-T	foliage spray	37, 97
		Ammate	foliage spray	97
		D-T	mixed esters, foliage spray	43, 97
vernix	poison sumac	2,4-D	foliage spray	52, 54, 57, 97
		2,4,5-T	aqueous foliage spray	54
		Ammate	aqueous foliage spray	52, 54, 122
hynchospora corniculata	tadpole sedge	2,4-D		98
ibes	currant	2,4,5-T	foliage spray	57, 97
americanum	American black currant	2,4-D 2,4,5-T D-T	salts and esters esters mixed esters } foliage spray	80, 97
binominatum	Siskiyou gooseberry	2,4,5-T	salts, foliage spray	80
hudsonianum	Hudson Bay currant	2,4-D 2,4,5-T D-T	salts and esters esters mixed esters } foliage spray	80
inerme	white-stem gooseberry	2,4,5-T	esters, foliage spray	80
lacustre	black swamp currant or prickly currant or bristly black currant	2,4,5-T	esters, foliage spray	97
nevadense	Sierra Nevada currant	D-T	mixed esters, foliage spray	80
oxyacanthoides	northern or Canada gooseberry	2,4-D	foliage spray, salts and esters	97

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
Ribes petiolare	western black currant	2,4,5-T	ester, foliage spray	80
roezli	Sierra Nevada gooseberry	2,4-D	salts and esters, foliage spray and cut surface application	80
viscosissimum	sticky currant	2,4,5-T	ester, foliage spray	80
Richardia scabra	Richards-weed or Mexican-clover	2,4-D	8# per acre, pre-emergence spray	70
Robinia pseudoacacia	black locust or false-acacia	2,4-D 2,4,5-T	esters, foliage spray	80, 97
		D-T	mixed esters, foliage spray, tested on stump sprouts only	43, 80, 97
Rosa bracteata	Macartney or Chickasaw rose	2,4-D		11, 17
		2,4-D	ester in water, foliage spray	126
eglanteria (rubiginosa)	sweetbrier or eglantine	2,4,5-T	ester, foliage spray	51
laevigata	Cherokee rose	2,4-D		11, 17
rubiginosa (see *R. eglanteria*)				
Rubus	bramble	2,4,5-T	foliage spray	57, 97
Rubus	blackberry	D-T	mixed esters, foliage spray	80
Rubus	raspberry	Ammate		52
allegheniensis	blackberry	2,4-D		11
		2,4-D	ester	30
		2,4,5-T	foliage spray, esters	37, 51, 71
		D-T	mixed esters, foliage spray	43, 51
hispidus	(swamp) blackberry or swamp dewberry	2,4,5-T		71
		D-T	mixed esters, foliage spray	43
occidentalis	blackcap or black raspberry	D-T	mixed esters, foliage spray	97
odoratus	(purple-) flowering raspberry	2,4-D	foliage spray	42
		D-T	mixed esters, foliage spray	43
villosus	dewberry	D-T	mixed esters, foliage spray	43
Rudbeckia hirta	black-eyed susan	D-T	mixed esters, foliage spray	43
Rumex acetosa	garden sorrel	2,4-D		49

cientific Name	Common name	Compound	Remarks	References
umex acetosella	common or red or sheep sorrel	2,4-D	Na and amine salts	3
			ammonium salt	24
			high concentration	79
		DNOCHP DNOSBP	in oil emulsion	102
		MCPA	Na salt as dust	109
crispus	yellow or curly dock	2,4-D	high concentration	30, 57
		MCPA	Na salt, 4# per acre	58
obtusifolius	bitter dock	2,4-D		49, 79, 124
agittaria	arrowhead	2,4-D		30, 98
guayamensis	arrowhead	2,4-D		22
alix	willow	2,4-D	ethyl ester, foliage spray	36, 37, 80, 97
			esters, two applications	82
		2,4,5-T	esters, foliage spray	37, 80, 97
		Ammate	foliage spray	36, 52
		Ammate	crystals in cups at base of trunk	25, 26, 90
			crystals in frills on trunk	26, 64
		D-T	mixed esters, foliage spray	97
cordata *discolor* *rostrata*	heart-leaf willow pussy willow beaked willow	2,4-D	foliage spray	42, 57
		D-T	mixed esters, foliage spray	43
longifolia	sandbar willow	D-T	mixed esters on cut surface (in oil), or foliage spray	80
nigra	black willow	2,4-D		11, 17
		D-T	mixed esters, foliage spray	80
Sambucus canadensis	elderberry or common or American elder	2,4-D	foliage spray acid	42, 97
			foliage spray esters	37, 57, 80, 97
		2,4,5-T	esters, foliage spray	37
		Ammate	foliage spray	97
		D-T	mixed esters, foliage spray	43, 97
Sapium sebiferum	Chinese tallow-tree	2,4-D		17
Sassafras albidum	sassafras	2,4-D	foliage spray	66, 67, 97, 119
		2,4,5-T	foliage spray	57, 97
		D-T	mixed esters, foliage spray	80, 97
Saxifraga	saxifrage	2,4-D	high concentration	75

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCE
Scandix pecten-veneris	shepherds-needle	2,4-D	Na salt ———	14
			Na salt high concentration	76
		MCPA	high concentration	76
			Na salt	14
Senecio jacobaea	ragwort or tansy ragwort	2,4-D	high concentration	75
		MCPA	Na salt, 4# per acre	58
vulgaris	common groundsel	2,4-D		75
		MCPA	Na salt as dust	109
Sesbania exaltata (*S. macrocarpa*)	indigo (plant) or coffee-weed	2,4-D		11, 17, 20,
Sesuvium portulacastrum	sea-side purslane	2,4-D	Na salt, butyl ester, 2# per acre	73
		MCPA	Na salt, 2# per acre	
Setaria	foxtail	2,4-D	Na salt	60, 117, 11
		DNOC	Na salt	30
		IPC		30, 47
		LPOF		53
glauca	yellow foxtail	2,4-D		38
Silene cucubalus (*S. inflata*)	bladder campion	2,4-D	Na salt, high concentration	76
		MCPA	high concentration	
Sinapis arvensis (see also *Brassica kaber*)	yellow charlock	2,4-D		49, 75
		2,4-D	Na salt	76
		DNOC	ammonium salt	15
		DNOSBP		96
		MCPA		76
		MCPA	Na salt	15
			postemergence application	109, 110
Sisymbrium altissimum	Jim Hill mustard or tumble-mustard	2,4-D		4
Smilax rotundifolia	common greenbrier or common catbrier	D-T	mixed esters, foliage spray	97
Solanum auriculatum	bug-tree or bug-weed or violet nightshade	2,4-D		12
carolinense	horse-nettle	2,4,5-T		71
dulcamara	bitter-sweet or nightshade	2,4-D		4
		2,4,5-T	foliage spray	57
		DNOSBP	ammonium salt	30
		D-T	mixed esters, foliage spray	43

ientific Name	Common name	Compound	Remarks	References
lanum nigrum	black nightshade	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
lidago	goldenrod	Ammate	foliage spray	63
altissima *aspera* (*rugosa aspera*) *bicolor* *graminifolia* (see below also) *juncea* *nemoralis* *rugosa* (see below also)	goldenrod	2,4-D D-T	high concentration mixed esters, foliage spray	57 43
olidago *graminifolia* *rugosa*	goldenrod	2,4-D	foliage spray	42
onchus arvensis	perennial or field sow-thistle	2,4-D	high concentration	75
			applied to cut stem	29
			1# per acre, postemergence spray	104, 105
			Na salt high concentration	10, 76
			butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	73
			high concentration	76
oleraceus	common sow-thistle	2,4-D	ammonium salt	24
			Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	73
		MCPA	postemergence application, dust partially effective	109, 110
orbus aucuparia	European mountain-ash	2,4-D	high concentration	75
			esters, two applications	82
orghum halepense (*Holcus h.*)	Johnson grass	MH		31, 32, 129, 130
vulgare sudanense	Sudan grass	LPOF		53
		MH		31
pecularia hybrida (*Legousia hybrida*)	Venus looking-glass	DNOSBP		96
pergula arvensis	(corn) spurry	2,4-D		17
		MCPA	Na salt as dust	109

Scientific Name	Common name	Compound	Remarks	Referenc
Spiraea latifolia	meadow-sweet	2,4-D	foliage spray	42
		D-T	mixed esters, foliage spray	43
tomentosa	hardhack or steeple-bush	2,4-D	foliage spray	42
		D-T	mixed esters, foliage spray	43, 80
Stellaria media	common chick-weed	2,4-D	high concentration	54, 57
			as dust in soil	112
		IPC	as dust mixed with talc	27
			foliage spray	57
			at or prior to germination	47, 112
		MCPA	Na salt as dust	109, 112
		IPC-2,4-D IPC-MCPA	better than either alone	112
		DNOC	Na salt	30
		DNOCHP DNOSBP	in oil emulsion	102
		DNOSBP		71, 96
		DNOSAP		34
		EH-1		72
Striga densiflora *lutea*	striga	2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Symphoricarpos albus	snowberry	2,4-D	ester, foliage spray	80
orbiculatus	Indian-currant or coral-berry	2,4-D D-T	esters mixed esters foliage spray	97
Tagetes minuta	marigold or Muster John Henry	2,4-D	Na and amine salts	3
Tamarix gallica	salt-cedar or French tamarisk	2,4-D	ester in oil, applied to cut surface, 5% sol.	80
Taraxacum officinale	common dandelion	2,4-D		4, 9, 10, 4 71, 95, 1
		2,4-D	high concentration	30, 54, 57,
		DNOCHP DNOSBP	in oil emulsion	102
		MCPA	Na salt, 4# per acre	58
Thlaspi arvense	fanweed or penny-cress or French-weed	2,4-D		75, 87
		2,4-D	½# per acre, post-emergence spray	105
			Na salt	15, 76
		DNOC	Ammonium salt	15
		MCPA		15, 76
		MCPA	Na salt as dust	109

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
Thyella tamnifolia (see *Jacquemontia*)				
Tragopogon				
porrifolius	goats-beard	2,4-D	high concentration	57, 75
pratensis	goats-beard	MCPA	Na salt, 4# per acre	58
Trichachne insularis	sour grass	2,4-D	ester in diesel oil	83
Tridax procumbens		2,4-D	Na salt, butyl ester, 1# per acre	73
		MCPA	Na salt, 1# per acre	
Trifolium repens	white clover	MCPA 2,4-D	acid Na salt } high concentration	76
Tussilago farfara	coltsfoot	2,4-D	Na salt, effective in spring and early summer	10
Ulmus alata	Wahoo elm or winged elm	2,4-D	ester in water, foliage spray	36, 97, 126
		2,4,5-T	ester in oil, trunk notch	36, 126
		Ammate	crystals on trunk in frills	64
			crystals on trunk in cups at base	90, 92
		D-T	mixed esters, foliage spray	80
americana	American elm	2,4-D	foliage spray acid	42, 57, 66, 67
			foliage spray esters	37
		2,4,5-T	esters, foliage spray	37, 97
		Ammate	foliage spray	97
		Ammate	crystals on trunk in frills	64
			crystals on trunk in cups at base	90, 92
		D-T	mixed esters, foliage spray	43, 80, 97
fulva	slippery elm	D-T	mixed esters, foliage spray	80, 97
Urtica dioica	stinging nettle	2,4-D	high concentration	57, 75
		D-T	mixed esters, foliage spray	43
		MCPA	Na salt on young plants	58
urens	dog or burning nettle	2,4-D	high concentration	75
Uvularia sessilifolia (*Oakesia sessilifolia*)	bellwort or wild-oats	2,4-D	foliage spray	42
		D-T	mixed esters, foliage spray	43
Vaccinium angustifolium laevifolium (*V. pennsylvanicum*)	lowbush blueberry	2,4-D	foliage spray	42
		Ammate	foliage spray	97
		D-T	mixed esters, foliage spray	43

SCIENTIFIC NAME	COMMON NAME	COMPOUND	REMARKS	REFERENCES
Vaccinium corymbosum	highbush blueberry	2,4-D D-T	foliage spray mixed esters, stump painting, foliage spray	42 43
pennsylvanicum (see *V. angustifolium*)				
Vandellia pedunculata		2,4-D	sodium and triethanolamine salts	68
Veratrum viride	false-hellebore or American white-hellebore	D-T	mixed esters, foliage spray, plants up to 6″ tall easily killed	43
Verbascum thapsus	common mullein	2,4-D D-T	foliage spray high concentration mixed esters, foliage spray, flowering shoots resistant	42 57 43
Veronica hederaefolia	ivy-leaved speedwell	DNOC	ammonium salt	14
officinalis	common speedwell	2,4-D	high concentration	57
Viburnum cassinoides	wild-raisin or witherod	D-T	mixed esters, foliage spray, midsummer foliage resistant	43
lentago	nanny-berry			
lentago	nanny-berry	2,4-D	foliage spray	42
Vicia	vetch	2,4-D MCPA		4, 75, 88 88
Viola tricolor	hearts-ease or wild pansy	2,4-D MCPA	high concentration Na salt as dust	75 109
Vitis	grape	2,4-D	esters, foliage spray	57
riparia	riverbank grape	2,4-D 2,4,5-T Ammate D-T	esters, foliage and cut surface spray salt foliage mixed esters spray	97
vulpina	wild or frost grape	D-T	mixed esters, foliage spray	80
Xanthium canadense (*americanum*)	cocklebur	2,4-D		11, 17
pensylvanicum	cocklebur	2,4-D 2,4-D	 ½# per acre, postemergence spray	4, 57 104, 105
strumarium	cocklebur	2,4-D MCPA	Na salt, butyl ester, 1# per acre Na salt, 1# per acre	73
Xanthoxylum (*Zanthoxylum*)	prickly-ash	2,4,5-T	foliage spray	57

Courtesy Michigan State College

Jeep-mounted piston-type pump and boom built for spraying large lawns.

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ALPHABETICAL LIST OF COMMON NAMES OF PLANTS ON PAGES 59 TO 90

With the scientific names under which they are to be found

COMMON NAME	SCIENTIFIC NAME
acacia, false-	*Robinia*
ageratum	*Ageratum*
alder	*Alnus*
alligator-weed	*Alternanthera*
alyssum, hoary-	*Berteroa*
apple	
crab	*Malus*
-of-Peru	*Nicandra*
thorn-	*Datura*
aroma (marabu)	*Cailliea*
arrowhead	*Sagittaria*
artichoke, Jerusalem	*Helianthus*
ash	*Fraxinus*
mountain-	*Sorbus*
prickly-	*Xanthoxylum*
aspen	*Populus*
asthma-plant	*Euphorbia*
autumn-crocus	*Colchicum*
bachelors-button	*Centaurea*
bag-pod	*Glottidium*
banana	*Musa*
barberry	*Berberis*
barilla	*Halogeton*
barnyard grass	*Echinochloa*
basil	*Ocimum*
bat-wing	*Commelina*
bawchee seed plant	*Psoralea*
bay, sweet	*Magnolia*
bearberry	*Arctostaphylos*
beech	*Fagus*
beggars-ticks	*Bidens*
bellwort	*Uvularia*
bentgrass	*Agrostis*
Bermuda-buttercup	*Oxalis*
Bermuda grass	*Cynodon*
billy-goat weed	*Ageratum*
bindweed	*Convolvulus* *Polygonum*
birch	*Betula*
bird-eye	*Caperonia*
bistort	*Polygonum*
bitternut (hickory)	*Carya*
bitter-sweet	*Solanum*
blackberry	*Rubus*
blackbrush	*Acacia*
blackcap	*Rubus*
black-eyed Susan	*Rudbeckia*
black gum	*Nyssa*
blackthorn	*Bursaria*
bladder-pod	*Glottidium*
blueberry	*Vaccinium*
blue-brush	*Condalia*

COMMON NAME	SCIENTIFIC NAME
blue-devil blue-weed	*Echium*
box-elder	*Acer*
boys-and-girls	*Mercurialis*
bracken	*Pteridium*
bramble	*Rubus*
brome grass	*Bromus*
buckeye	*Aesculus*
buckhorn (plantain)	*Plantago*
buckwheat, wild-	*Polygonum*
bugloss, vipers-	*Echium*
bug-tree bug-weed	*Solanum*
bur-clover	*Medicago*
burdock	*Arctium*
bush-honeysuckle	*Diervilla*
butter-and-eggs	*Linaria*
buttercup	*Ranunculus*
Bermuda-	*Oxalis*
button-bush	*Cephalanthus*
buttonweed	*Diodia*
button-willow	*Cephalanthus*
buttonwood	*Platanus*
cactus	*Opuntia*
camomile	*Anthemis* *Matricaria*
campion	*Lychnis* *Silene*
canary grass	*Phalaris*
carpet grass	*Axonopus*
carrot, wild	*Daucus*
catalpa	*Catalpa*
catbrier	*Smilax*
cats-ear	*Hypochoeris*
cedar	
ground-	*Lycopodium*
salt-	*Tamarix*
chamomile	*Anthemis* *Matricaria*
charlock	*Brassica* *Raphanus*
cheat (grass)	*Bromus*
cherry	*Prunus*
chervil, wild	*Anthriscus*
chess	*Bromus*
chestnut	*Castanea*
chickweed	*Cerastium* *Stellaria*
chicory	*Cichorium*
Chinese tallow-tree	*Sapium*
chokeberry	*Aronia*
cholla cactus	*Opuntia*

COMMON NAME	SCIENTIFIC NAME
inquefoil	*Potentilla*
leavers	*Galium*
lover	*Trifolium*
bur-	*Medicago*
Mexican-	*Richardia*
love-strip	*Jussiaea*
ockle	*Agrostemma*
ocklebur	*Xanthium*
ockscomb	*Celosia*
oco-grass	*Cyperus*
offee-bean, old-fashion	*Glottidium*
offee-weed	*Sesbania*
ohitre	*Commelina*
oltsfoot	*Tussilago*
opper-leaf	*Acalypha*
oral-berry	*Symphoricarpos*
erchorus	*Corchorus*
orn chamomile	*Anthemis*
orn cockle	*Agrostemma*
ornflower	*Centaurea*
orn-marigold	*Chrysanthemum*
otton-thistle	*Onopordum*
ottonwood	*Populus*
oyote brush	*Baccharis*
rab apple	*Malus*
rab grass	*Digitaria*
ranesbill	*Geranium*
ress	
early-	*Barbarea*
hoary-	*Cardaria*
penny-	*Thlaspi*
winter-	*Barbarea*
rocus, autumn-	*Colchicum*
up grass	*Eriochloa*
urly-indigo	*Aeschynomene*
urrant	*Ribes*
Indian-	*Symphoricarpos*
laisy	*Bellis* *Chrysanthemum* *Eclipta*
fleabane	*Erigeron*
landelion	*Taraxacum*
lay-flower	*Commelina*
lead-nettle	*Lamium*
levil, king	*Hieracium*
levils paintbrush	
lewberry	*Rubus*
lock	*Rumex*
lodder	*Cuscuta*
logbane	*Apocynum*
log-fennel	*Anthemis*
logwood	*Cornus*
lollar-grass	*Hydrocotyle*
arly-cress	*Barbarea*
arth-smoke	*Fumaria*
glantine	*Rosa*
elder	*Sambucus*
box-	*Acer*
marsh-	*Iva*

COMMON NAME	SCIENTIFIC NAME
evening-primrose	*Oenothera*
everlasting	*Anaphalis*
fanweed	*Thlaspi*
fat-hen	*Chenopodium*
saltbush	*Atriplex*
fennel, dog-	*Anthemis*
fern	
resam	*Gleichenia*
sweet-	*Comptonia*
fescue	*Festuca*
fiddle-neck	*Amsinckia*
filbert	*Corylus*
fimbristylis	*Fimbristylis*
five-finger	*Potentilla*
fleabane	*Erigeron*
flower-of-an-hour	*Hibiscus*
four-o'clock	*Mirabilis*
foxtail	*Setaria*
French-grass	*Commelina*
French-pink	*Centaurea*
French-weed	*Commelina* *Thlaspi*
fumitory	*Fumaria*
galinsoga	*Galinsoga*
garlic	*Allium*
gill-over-the-ground	*Glechoma*
girls, boys-and-	*Mercurialis*
goats-beard	*Tragopogon*
goldenrod	*Solidago*
good King Henry	*Chenopodium*
gooseberry	*Ribes*
goosefoot	*Chenopodium*
goose grass	*Eleusine*
grape	*Vitis*
grass	
barnyard	*Echinochloa*
bent	*Agrostis*
Bermuda	*Cynodon*
brome	*Bromus*
canary	*Phalaris*
carpet	*Axonopus*
cheat	*Bromus*
coco-	*Cyperus*
crab	*Digitaria*
cup	*Eriochloa*
dollar-	*Hydrocotyle*
French-	*Commelina*
goose	*Eleusine*
Johnson	*Sorghum*
knot-	*Polygonum*
love	*Eragrostis*
nut-	*Cyperus*
panic	*Panicum*
pepper-	*Lepidium*
pigeon	*Panicum*
quack	*Agropyron*
redtop	*Agrostis*
rib-	*Plantago*
ripgut (brome)	*Bromus*
rye	*Lolium*

COMMON NAME	SCIENTIFIC NAME
grass (*continued*)	
savannah	*Axonopus*
sour	*Trichachne*
stink	*Eragrostis*
Sudan	*Sorghum*
sweet vernal	*Anthoxanthum*
tickle	*Panicum*
velvet	*Holcus*
water	*Echinochloa*
wire	*Eleusine*
witch	*Agropyron* *Panicum*
greenbrier	*Smilax*
ground cedar	*Lycopodium*
ground ivy	*Glechoma*
ground-pine	*Lycopodium*
groundsel	*Senecio*
guao	*Comocladia*
gum, black	*Nyssa*
gum-plant	*Grindelia*
gum, sour	*Nyssa*
gum, sweet	*Liquidambar*
gumweed	*Grindelia*
hackberry	*Celtis*
hardhack	*Potentilla* *Spiraea*
hawkbit	*Leontodon*
hawks-beard	*Crepis*
hawkweed	*Hieracium*
hawthorn	*Crataegus*
hazel	*Corylus*
witch-	*Hamamelis*
heal-all	*Prunella*
hearts-ease	*Viola*
hellebore	*Veratrum*
hemlock	
poison-	*Conium*
water-	*Cicuta*
hemp nettle	*Galeopsis*
henbit	*Lamium*
Henry, good King	*Chenopodium*
herb-mercury	*Mercurialis*
herons-bill	*Erodium*
hickory	*Carya*
hoary alyssum	*Berteroa*
hoary-cress	*Cardaria*
hogmeat hogweed	*Boerhaavia*
honey-locust	*Gleditsia*
honeysuckle	*Lonicera*
bush-	*Diervilla*
hop hornbeam hornbeam, hop-	*Ostrya*
horse-nettle	*Solanum*
horsetail	*Equisetum*
horse-weed	*Erigeron*
huisache	*Acacia*
hyacinth, water-	*Eichhornia*
Indian currant	*Symphoricarpos*
Indian strawberry	*Duchesnea*

COMMON NAME	SCIENTIFIC NAME
Indigo	*Aeschynomene* *Indigofera* *Sesbania*
ironwood	*Ostrya*
ivy	
ground-	*Glechoma*
poison-	*Rhus*
Jerusalem artichoke	*Helianthus*
Jerusalem-oak	*Chenopodium*
jessamine	*Gelsemium*
Jews-mallow	*Corchorus*
Jim Hill mustard	*Sisymbrium*
Jimson-weed	*Datura*
Johnson grass	*Sorghum*
joint-vetch	*Aeschynomene*
Juneberry	*Amelanchier*
juniper	*Juniperus*
kalmia, lambkill	*Kalmia*
kelp	*Polygonum*
king devil	*Hieracium*
King Henry, good	*Chenopodium*
knapweed	*Centaurea*
knot-grass knotweed	*Polygonum*
kudzu-vine	*Pueraria*
ladys-mantle	*Alchemilla*
ladys-thumb	*Polygonum*
lambkill (kalmia)	*Kalmia*
lambs-quarters	*Chenopodium*
lantana	*Lantana*
laurel	
mountain-	*Kalmia*
seaside-	*Phyllanthus*
sheep-	*Kalmia*
leaf-flower	*Phyllanthus*
lettuce, wild	*Lactuca*
lily-of-the-valley, false or wild	*Maianthemum*
locust	*Robinia*
honey-	*Gleditsia*
looking-glass, Venus	*Specularia*
loosestrife, West Indian	*Jussiaea*
lote (wood)	*Condalia*
love grass	*Eragrostis*
male-berry	*Lyonia*
mallow	*Malva*
Jews-	*Corchorus*
maple	*Acer*
marigold	*Tagetes*
corn-	*Chrysanthemum*
marsh-elder	*Iva*
Mayweed	*Anthemis* *Matricaria*
meadow-sweet	*Spiraea*
mercury	
herb-	*Mercurialis*
three-seeded	*Acalypha*
mesquite	*Prosopis*
Mexican-clover	*Richardia*

COMMON NAME	SCIENTIFIC NAME
lexican-weed	*Caperonia*
ilkweed	*Asclepias* *Euphorbia*
ioneywort	*Lysimachia*
iorning-glory	*Convolvulus* *Ipomoea*
iountain-ash	*Sorbus*
iountain-laurel	*Kalmia*
iouse-ear chickweed	*Cerastium*
iud-plantain	*Heteranthera*
iugwort	*Artemisia*
iule-ear	*Heteranthera*
iullein	*Verbascum*
iustard	
Jim Hill-	*Sisymbrium*
tumble-	
luster John Henry	*Tagetes*
iyrtle, wax-	*Myrica*
anny-berry	*Viburnum*
ettle	*Urtica*
hemp-	*Galeopsis*
horse-	*Solanum*
ightshade	*Solanum*
ut-grass	*Cyperus*
ak	*Quercus*
Jerusalem-	*Chenopodium*
poison-	*Rhus*
at, wild	*Avena*
ats, wild-	*Uvularia*
nion	
wild	*Allium*
wild-	*Cyperus*
rach	*Atriplex*
range, Osage-	*Maclura*
sage-orange	
xalis	*Oxalis*
x-eye daisy	*Chrysanthemum*
aintbrush, devils	*Hieracium*
anic grass	*Panicum*
ansy, wild	*Viola*
each	*Prunus*
ear	*Pyrus*
prickly-	*Opuntia*
ea, scurfy-	*Psoralea*
ecan	*Carya*
enny-cress	*Thlaspi*
ennywort	*Hydrocotyle*
epper-grass	*Lepidium*
epperidge	*Nyssa*
epper-vine	*Ampelopsis*
ersimmon	*Diospyros*
igeon grass	*Panicum*
igweed	*Amaranthus* *Chenopodium*
impernel	*Anagallis*
ine	*Pinus*
ground-	*Lycopodium*
ink, French-	*Centaurea*
lane-tree	*Platanus*

COMMON NAME	SCIENTIFIC NAME
plantain	*Plantago*
mud-	*Heteranthera*
water-	*Alisma*
plum	*Prunus*
poinsettia	*Euphorbia*
poison-hemlock	*Conium*
poison-ivy	*Rhus*
poison-oak	
poison sumac	
poplar	*Populus*
tulip-	*Liriodendron*
yellow-	
poppy	*Papaver*
prickly-	*Argemone*
potato, sweet-, wild	*Ipomoea*
prickly-ash	*Xanthoxylum*
prickly-pear (cactus)	*Opuntia*
prickly-poppy	*Argemone*
primrose	
evening-	*Oenothera*
water-	*Jussiaea*
-willow	
purple cockle	*Agrostemma*
purslane	*Portulaca*
seaside-	*Sesuvium*
quack grass	*Agropyron*
quail-grass	*Celosia*
radish, wild	*Raphanus*
ragweed	*Ambrosia*
ragwort	*Senecio*
raisin, wild-	*Viburnum*
raspberry	*Rubus*
rattle-box	*Crotalaria*
rattle, yellow-	*Rhinanthus*
red-root (pigweed)	*Amaranthus*
red-stem	*Ammannia*
redtop (grass)	*Agrostis*
redweed	*Melochia*
resam (fern)	*Gleichenia*
rib-grass	*Plantago*
Richards weed	*Richardia*
ripgut (brome grass)	*Bromus*
Robin, run-away-	*Glechoma*
rocket, wall-	*Diplotaxis*
rose	*Rosa*
run-away-Robin	*Glechoma*
rush	*Juncus*
rye grass	*Lolium*
sagebrush	*Artemisia*
St. Johnswort	*Hypericum*
saltbush	*Atriplex*
salt-cedar	*Tamarix*
sassafras	*Sassafras*
savannah grass	*Axonopus*
saxifrage	*Saxifraga*
scarlet pimpernel	*Anagallis*
Scotch-thistle	*Onopordum*
scurfy-pea	*Psoralea*
seaside-laurel	*Phyllanthus*
seaside-purslane	*Sesuvium*

COMMON NAME	SCIENTIFIC NAME
sedge	*Cyperus* *Rhynchospora*
self-heal	*Prunella*
sensitive-plant	*Mimosa*
serviceberry shadbush	*Amelanchier*
sheep-laurel	*Kalmia*
sheep sorrel	*Rumex*
shepherds-needle	*Scandix*
shepherds-purse	*Capsella*
silver-rod	*Solidago bicolor*
silver-weed	*Potentilla*
smartweed	*Polygonum*
snakeroot, white	*Eupatorium*
snowberry	*Symphoricarpos*
sorrel	*Oxalis* *Rumex*
sour grass	*Trichachne*
sour gum	*Nyssa*
sow-thistle	*Sonchus*
speedwell	*Veronica*
spicebush	*Lindera*
spiderling	*Boerhaaria*
spiderwort, tropical	*Commelina*
spruce	*Picea*
spurge	*Euphorbia*
spurry	*Spergula*
star-thistle	*Centaurea*
steeple-bush	*Spiraea*
stink grass	*Eragrostis*
storksbill	*Erodium*
stramonium	*Datura*
strawberry, Indian-	*Duchesnea*
Sudan grass	*Sorghum*
sumac	*Rhus*
sunflower	*Helianthus*
Susan, black-eyed	*Rudbeckia*
sweet bay	*Magnolia*
sweetbrier	*Rosa*
sweet-fern	*Comptonia*
sweet gum	*Liquidambar*
sweet-potato, wild	*Ipomoea*
sweet vernal grass	*Anthoxanthum*
sycamore	*Platanus*
tacamahac	*Populus*
tadpole sedge	*Rhynchospora*
tallow-tree, Chinese	*Sapium*
tamarisk	*Tamarix*
tarweed	*Amsinckia*
Tasajillo cactus	*Opuntia*
tea-tree	*Leptospermum*
thistle	*Cirsium*
cotton- Scotch-	*Onopordum*
sow-	*Sonchus*
star-	*Centaurea*
thorn-apple	*Datura*
three-seeded mercury	*Acalypha*
tickle grass	*Panicum*
ticks, beggars-	*Bidens*

COMMON NAME	SCIENTIFIC NAME
tievine	*Jacquemontia*
toothcups	*Ammannia*
tulip-poplar tulip-tree	*Liriodendron*
tumble-mustard	*Sisymbrium*
tumbleweed	*Amaranthus*
turtle-back	*Commelina*
velvet grass	*Holcus*
velvet-leaf	*Abutilon*
yellow	*Limnocharis*
velvet-weed	*Abutilon*
Venus looking-glass	*Specularia*
vernal grass, sweet	*Anthoxanthum*
vetch	*Vicia*
joint-	*Aeschynomene*
yellow-	*Lathyrus*
vipers-bugloss	*Echium*
Virginia creeper	*Parthenocissus*
virgins-bower	*Clematis*
wall-rocket	*Diplotaxis*
walnut	*Juglans*
water grass	*Echinochloa*
water-hemlock	*Cicuta*
water-hyacinth	*Eichhornia*
water pennywort	*Hydrocotyle*
water-plantain	*Alisma*
water-primrose	*Jussiaea*
wattle	*Acacia*
wax-myrtle	*Myrica*
weir vine	*Ipomoea*
West Indian loosestrife	*Jussiaea*
white-hellebore	*Veratrum*
white snakeroot	*Eupatorium*
wild-buckwheat	*Polygonum*
wild oat	*Avena*
wild-oats	*Uvularia*
wild onion	*Allium*
wild-onion	*Cyperus*
wild-raisin	*Viburnum*
willow	*Salix*
button-	*Cephalanthus*
primrose-	*Jussiaea*
winterberry	*Ilex*
winter-cress	*Barbarea*
wintergreen	*Gaultheria*
wire grass	*Eleusine*
witch grass	*Agropyron* *Panicum*
witch-hazel	*Hamamelis*
witherod	*Viburnum*
woodbine	*Parthenocissus*
wormwood	*Artemisia*
yarrow	*Achillea*
yaupon	*Ilex*
yellow-poplar	*Liriodendron*
yellow-rattle	*Rhinanthus*
yellow-sorrel	*Oxalis*
yellow-vetch	*Lathyrus*
yerba-de Tajo	*Eclipta*

SYNTHETIC HORMONES AND OTHER CHEMICALS USEFUL IN GROWTH CONTROL—*classified by their commonest uses—the leading trade preparations, with their chemical make-up and their manufacturers' names*

Compiled by

George A. Vradenburg, Jr.

Use	*Trade Name*	*Chemical Name*	*Manufacturer*	*Page Reference*
FRUIT SETTING		benzothiazol-2-oxyacetic acid		25
	Fig Fix	p-chlorophenoxyacetic acid	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	8, 24
	Hormex	naphthaleneacetic acid	Benson-MacLean, Bridgeton, Ind.	16, 19, 33, 34
	Seed-Less-Set	ortho chlorophenoxy propionic acid	Plant Products Corp., Blue Point, N. Y.	16
	Sure-Set	p-chlorophenoxyacetic acid	Dow Chemical Co., Midland, Mich.	8, 16, 19, 20, 24, 37
	Thompson's Tomato Fix	naphthaleneacetic acid	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	16, 19, 33, 34
	Tomato Set	p-chlorophenoxyacetic acid	Westville Laboratories, Monroe, Conn.	8, 16, 19, 24, 37
PREVENTION OF PREHARVEST DROP OF APPLES, PEARS,	Apple-Lok	naphthaleneacetic acid	Westville Laboratories, Monroe, Conn.	8, 26, 27, 33
	App-L-Set App-L-Set Dust	sodium naphthalene acetate	Dow Chemical Co., Midland, Mich.	8, 26, 27
	Color-lok	2,4,5-trichlorophenoxy propionic acid	Westville Laboratories, Monroe, Conn.	27
	Color-Set	2,4,5-trichlorophenoxy propionic acid	Dow Chemical Co., Midland, Mich.	27
	Fruitone	naphthalene acetamide, naphthaleneacetic acid and derivatives	American Chemical Paint Co., Ambler, Pa.	8, 26, 38
	Hormex	naphthaleneacetic acid	Benson-MacLean, Bridgeton, Ind.	26
	Parmone	naphthaleneacetic acid	E. I. du Pont de Nemours & Co., Wilmington, Del.	8, 26
	Stop-Drop	naphthaleneacetic acid	Sherwin-Williams Paint Co., Bound Brook, N. J.	8, 26
	Thompson's Color-Fix	2,4,5-trichlorophenoxy propionic acid	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	27
	Thompson's Fruit Fix	naphthaleneacetic acid	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	8, 26
	Vitatone	naphthaleneacetic acid	Miller Products Co., Portland 1, Ore.	26
AND CITRUS FRUITS	Esteron 44	isopropyl ester of 2,4-D	Dow Chemical Co., Midland, Mich.	6, 28, 30
	2,4-Dow Weed Killer Formula 40	amine salt of 2,4-D		

Use	*Trade Name*	*Chemical Name*	*Manufacturer*	*Page Reference*
ROOTING OF CUTTINGS	Hormodin (in 3 strengths)	indolebutyric acid	Merck & Co., Inc., Rahway, N. J.	14, 37
	Hormo-Root		Hortus Products Co., Rutherford, N. J.	
	Rootone	naphthylacetamide, naphthyleneacetic acid and derivatives	American Chemical Paint Co., Ambler, Pa.	14, 38
	Thompson's Ree-Root (in 2 strengths)		Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	14
INHIBITING BUDS (SPROUTS) OF POTATOES	Dormatone	naphthaleneacetic acid	American Chemical Paint Co., Ambler, Pa.	17
	MH	maleic hydrazide	Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.	48, 58
	Sprout-lok	methyl ester of naphthaleneacetic acid	Westville Laboratories, Monroe, Conn.	17
	Thompson's Potato Fix (dust and liquid)	naphthaleneacetic acid	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	17
DEFOLIANT	Aero-Cyanamid Special Grade (dust)	calcium cyanamide	American Cyanamid Co., New York 20, N. Y.	
	Aero Sodium Cyanamid Soluble (X-50)	mono sodium cyanamide		
	Dow Spray 66 Improved	dinitro secondary butyl phenol	Dow Chemical Co., Midland, Mich.	
	Endothal	disodium 3,6-endoxahexahydrophthalate	Sharples Chemical Co., Philadelphia, Pa.	
	Geigy Potato Vine Killer and Weed Killer	sodium arsenite	Geigy Co., Inc., New York 8, N. Y.	
	Shed-a-Leaf	sodium chlorate and pentaborate	Chipman Chemical Co., Bound Brook, N. J.	
	Thompson's Defolicide 1 and 2	pentachlorophenol	Thompson Horticultural Chemicals Corp., Los Angeles, Calif.	58
PREVENTION OF FRUIT SETTING ON ORNAMENTAL TREES	App-L-Set App-L-Set Dust	sodium naphthalene acetate	Dow Chemical Co., Midland Mich.	8-13
	Dinitrol	4,6-dinitro-O-cresol	Sherwin-Williams Co., Cleveland, Ohio	11, 13, 58
	DN Dry Mix No. 1 DN111	dinitro-O-cyclohexylphenol	Dow Chemical Co., Midland, Mich.	11-13, 58
	DN289	dinitro-O-sec-butylphenol		
	Elgetol	sodium dinitro ortho cresolate	Standard Agricultural Chemical Co. Hoboken, N. J.	11-13

	MH	maleic hydrazide	Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.	11, 13, 58
		N-1-naphthyl-phthalamic acid	Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.	11-13
	Parmone	naphthaleneacetic acid	E. I. du Pont de Nemours & Co., Wilmington, Delaware	8, 11-13
SELECTIVE WEED KILLING FOR LAWNS, PASTURES, FIELD CROPS, ETC.	Agicide Weed Wilt	2,4-D acid equivalent	Agicide Co., Inc., Racine, Wis.	6, 40, 41, 44, 46, 48, 50, 53-58
	Amine Weed Killer 60	amine salt of 2,4-D	E. I. du Pont de Nemours & Co., Wilmington, Delaware	
	Barweed	2,4-D	American Cyanamid Co., New York 20, N. Y.	
	Benoclor 3-C	chlorinated hydrocarbon	Cloroben Corporation of Jersey City, N. J.	57
	Chipman 2,4-D Amine No. 2	amine salt of 2,4-D	Chipman Chemical Co., Bound Brook, N. J.	6, 40, 41, 44, 46, 48, 50, 53-58
	Chipman 2,4-D ester (5% and 10% dust and 44% spray)	isopropyl ester of 2,4-D		
	Chipman 2,4-D Weed Killer (powder & liquid)	alkanolamine salt of 2,4-D		
	Crabgraxx plus 2,4-D	potassium cyanate and 2,4-D	Kelly Agricultural Products Co., McKeesport, Pa.	40, 41, 44
	Crag Herbicide 1	sodium 2,4-dichlorophenoxy-ethyl sulfate	Carbide and Carbon Chemicals Co., New York, N. Y.	49-51, 58
	Ded-Weed Aero Ester 74%	alkyl ester of 2,4-D	Thompson-Hayward Chemical Co., Kansas City 8, Mo.	6, 40, 41, 44, 46, 48, 50, 51, 53-58
	Ded Weed 40 Amine Salt	dimethylamine salt of 2,4-D		
	Ded-Weed Lawn Groom	amine salt of 2,4-D		
	Ded-Weed 40			
	Ded-Weed ME-4 40% ester	alkyl ester of 2,4-D		
	Ded Weed ME-5 46% ester			
	Dow Selective Weed Killer	ammonium dinitro butylphenate	Dow Chemical Co., Midland, Mich.	40
	Dow Sodium TCA 90%	sodium trichloroacetate	Dow Chemical Co., Midland, Mich.	40
	du Pont Lawn Weed Killer	isopropyl ester of 2,4-D	E. I. du Pont de Nemours & Co., Wilmington, Del.	6, 40, 41, 44, 46, 48, 50, 53-58
	Elgetol	sodium dinitro ortho cresolate	Standard Agricultural Chemical Co., Hoboken, N. J.	6, 58

Use	*Trade Name*	*Chemical Name*	*Manufacturer*	*Page Reference*
Selective Weed Killing for Lawns, Pastures, Field Crops, etc. (*Continued*)	Elkays Weed Killer	sodium salt of 2,4-D	Rexall Drug Co., New York, N. Y.	6, 40, 41, 44, 46, 48, 50, 53-58
	End-O-Weed	alkanolamine salt of 2,4-D	Swift & Co., Chicago, Ill.	
	Ester Air Spray	butyl ester of 2,4-D	Pittsburgh Agricultural Chemical Co., New York	
	Esteron 44	isopropyl ester of 2,4-D	Dow Chemical Co., Midland, Mich.	6, 40, 41, 44, 46, 48, 50, 53-58
	Esteron 10-10	polypropylene glycol butyl ether ester of 2,4-D (low volatile)		
	Garden Master 2,4-D Weed Killer Amine Salt	amine salt of 2,4-D	Geigy Co., Inc., New York, N. Y.	6, 40, 41, 44, 46, 48, 50, 51, 53-58
	Geigy 2,4-D Amine Weed Killer			
	Geigy Ester Weed Killer	butyl ester of 2,4-D acid		
	Geigy 2,4-D Ester Weed Killer, No. 4	isopropyl ester of 2,4-D		
	No. 6			
	Oil Spray			
	Geigy "Lo-V" Ester Weed Killer	low volatile ester of 2,4-D		
	Geigy 2,4-D Isopropyl Ester No. 333	isopropyl ester of 2,4-D		
	Gold Bear 80	sodium salt of 2,4-D	Swift & Co., Chicago, Ill.	6, 40, 41, 44, 46, 48, 50, 51, 53-58
	Gold Bear 40	amine salt of 2,4-D		
	Gold Bear 44	isopropyl ester of 2,4-D		
	Hozzer-cide 2,4-D	isopropanolamine salts of 2,4-D acid	Accurate Tool Co., Newark, N. J.	6, 40, 41, 44, 46, 48, 50, 53-58
	Improved Weed-B-Gon	tetrahydrofurfuryl esters of 2,4-D and 2,4,5-T	California Spray Chemical Co., Richmond, Calif.	40
	Kathon E-40	isopropyl ester of 2,4-D	Rohm & Haas Co., Philadelphia, Pa.	6, 40, 41, 44, 46, 48, 50, 53-58
	Kathon E-33			
	Kathon M7	dimethylamine salt of 2,4-D		

Killer	chlorophenoxyacetic acid		
Methoxone	sodium salt of 2-methyl-4-chlorophenoxyacetic acid	Chipman Chemical Co., Bound Brook, N. J.	58
MH	maleic hydrazide	Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.	18, 58
Niagara Am. Sol.	amine salt of 2,4-D	Niagara Sprayer & Chemical Co., Middleport, N. Y.	6, 40, 41, 44, 46, 48, 50, 51, 53-58
Niagara Esta Sol.	isopropyl ester of 2,4-D		
90% Sodium TCA Weed Killer	sodium trichloroacetate	E. I. du Pont de Nemours & Co., Wilmington, Del.	40, 52, 58
Pittsburgh Amine Weed Killer No. 40	dimethylamine salt of 2,4-D	Pittsburgh Agricultural Chemical Co., New York, N. Y.	6, 40, 41, 44, 46, 48, 50, 53-58
Pittsburgh Ester Air Spray	butyl ester of 2,4-D		
Pittsburgh Ester Weed Killer No. 40	butyl 2,4-dichlorophenoxy acetate		
Pittsburgh Ester Weed Killer No. 44	isopropyl ester of 2,4 D		
Scott's Weed & Feed	2,4-D acid equivalent; 7-11-5 commercial fertilizer	O. M. Scott & Sons, Marysville, Ohio	6, 40, 41, 44, 46, 48, 50, 53-58
Scott's 4-XD	2,4-D		
Stantox P44 Weed Killer	isopropyl ester of 2,4-D	Standard Agricultural Chemical Co., Hoboken, N. J.	6, 40, 41, 44, 46, 48, 50, 53-58
Stantox 64 Liquid Weed Killer	alkanolamine (ethanol and isopropanol series) salts of 2,4-D		
Stantox Sodium TCA	sodium trichloracetate		
TAT C-Lect	N-phenylmercuriethylenediamine	O. E. Linck Co., Clifton, New Jersey	44
Thompson's Weedicide Amine Concentrate	amine salt of 2,4-D	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	6, 40, 41, 44, 46, 48, 50, 53-58
Thompson's Weedicide Rancher Butyl Ester	butyl ester of 2,4-D		
Thompson's Weedicide 50% Butyl Ester			
Thompson's Weedicide 45%	isopropyl ester of 2,4-D	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	6, 40, 41, 44, 46, 48, 50, 53-58
Thompson's Weedicide 40%	butyl ester of 2,4-D		

Use	*Trade Name*	*Chemical Name*	*Manufacturer*	*Page Reference*
SELECTIVE WEED KILLING FOR LAWNS, PASTURES, FIELD CROPS, ETC. *(Continued)*	2,4-D Amine Weed Killer	amine salt of 2,4-D	E. I. du Pont de Nemours & Co., Wilmington, Del.	6, 40, 41, 44, 46, 48, 50, 53-58
	2,4-D Ester Weed Killer	isopropyl ester of 2,4-D		
	2,4-Dow Weed Killer Formula 40	amine salt of 2,4-D	Dow Chemical Co., Midland, Mich.	6, 40, 41, 44, 46, 48, 50, 51, 53-58
	Weedanol 40% Concentrate		Associated Chemists, Inc., North Collins, N. Y.	
	Weedanol 40% Liquid			
	Weedanol M			
	Weedanol 70% Powder			
	Weedanol 27% Liquid			
	Weedanol Sodium TCA	trichloroacetate	Associated Chemists, Inc., North Collins, N. Y.	40, 52, 58
	Weedar MCP	2-methyl-4-chlorophenoxyacetic acid	American Chemical Paint Co., Ambler, Pa.	58
	Weedar 64	alkanolamine salt of 2,4-D	American Chemical Paint Co., Ambler, Pa.	6, 40, 41, 44, 46, 48, 50, 52, 53-58
	Weedmaster 40	alkanolamine salt of 2,4-D	Michigan Chemical Corp., St. Louis, Mich.	6, 40, 41, 44, 46, 48, 50, 52, 53-58
	Weedmaster 44	isopropyl ester of 2,4-D		
	Weed-No-More 14	butyl ester of 2,4-dichlorophenoxy acetate	Sherwin-Williams Co., Cleveland, Ohio	6, 40, 41, 44, 46, 48, 50, 52, 53-58
	Weedone Aero-Concentrate 96	ethyl ester of 2,4-D	American Chemical Paint Co., Ambler, Pa.	6, 40, 41, 44, 46, 48, 50, 52, 53-58
	Weedone Chloro IPC	isopropyl-N-phenyl carbamate		
	Weedone Concentrate 48	ethyl ester 2,4-D		
	Weedust 20%			
	Weedone LV-4	butoxyethanol ester of 2,4-D		
	Weedout 2,4-D	triethanolamine salt of 2,4-D	Doggett-Pfeil Co., Springfield, N. J.	6, 40, 41, 44, 46, 48, 50,

SPECIFIC CROPS OR SPECIFIC WEEDS:				
ONION WEEDING	Aero-Cyanate	potassium cyanate	American Cyanamid Co., New York 20, N. Y.	
	Aero-Cyanate (Special Grade) (pre-emergence)	calcium cyanamide		
STRAWBERRY WEEDING	Crag Herbicide 1	sodium 2,4-dichlorophenoxyethyl sulfate	Carbide and Carbon Chemicals Co., New York, N. Y.	49, 51, 58
	Weedone IPC	isopropyl n-phenyl carbamate	American Chemical Paint Co., Ambler, Pa.	58
CHICKWEED KILLING	Aero-Cyanate	potassium cyanate	American Cyanamid Co., New York 20, N. Y.	
	Atlas "A"	sodium arsenite	Chipman Chemical Co., Bound Brook, N. J.	
	Crabgraxx plus 2,4-D	potassium cyanate and 2,4-D	Kelly Agricultural Products Co., McKeesport, Pa.	
	C. W. K. Chickweed Killer	potassium cyanate and sodium arsenite	Garden Products Co., St. Louis, Mo.	
	Dow Selective Weed Killer	ammonium dinitro butyl phenate	Dow Chemical Co., Midland, Mich.	
	Weedone Crabgrass Killer	potassium cyanate	American Chemical Paint Co., Ambler, Pa.	
	Zotox	sodium arsenite	Garden Products Co., St. Louis, Mo.	
CLOVER KILLING	Atlas "A"	sodium arsenite	Chipman Chemical Co., Bound Brook, N. J.	
	Endothal	disodium 3,6-endoxahexahydrophthalate	Sharples Chemical Co., Philadelphia, Pa.	
	Niagrathol	disodium 3,6-endoxahexahydrophthalate	Niagara Sprayer & Chemical Co., Middleport, N. Y.	
WILD ONION KILLING	MH	maleic hydrazide	Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.	48, 58
BRUSH AND WOODY PLANT KILLING	Chipman Brush Killer	isopropyl ester of 2,4-D	Chipman Chemical Co., Bound Brook, N. J.	6, 40, 41, 44, 46, 48, 50, 53-58
	Ded-Weed LV-6 Brush Kil	low volatile esters of 2,4,5-T	Thompson-Hayward Chemical Co., Kansas City 8, Mo.	40, 53-55, 58
	Ded-Weed LV-33 Brush Kil	low volatile esters of 2,4-D and 2,4,5-T		
	Ded-Weed T-5 Brush Kil	alkyl ester of 2,4,5-T		
	Ded-Weed 2-1 Brush Kil	alkyl esters of 2,4-D and 2,4,5-T		

Use	*Trade Name*	*Chemical Name*	*Manufacturer*	*Page Reference*
BRUSH AND WOODY PLANT KILLING (*Continued*)	Esteron Brush Killer	low volatile esters of 2,4-D and 2,4,5-T	Dow Chemical Co., Midland, Mich.	40, 53-55, 58
	Esteron 245	low volatile polypropylene glycol butyl ether ester of 2,4,5-T		
	Geigy 2,4,5-T No. 400	butyl ester of 2,4,5-T	Geigy Co., Inc., New York 8, N. Y.	40, 53-55, 58
	Geigy Brush Killer No. 22	butyl esters of 2,4-D and 2,4,5-T		
	Geigy Brush Killer			
	Geigy "Lo-V" Brush Killer No. 300	low volatile polyethylene glycol 300 mono ester of 2,4,5-T		
	Geigy "Lo-V" Brush Killer No. 500	low volatile polyethylene glycol 200 mono ester of 2,4-D and low volatile polyethylene glycol 300 mono ester of 2,4,5-T		
	Improved Weed-B-Gon	tetrahydrofurfuryl esters of 2,4-D and 2,4,5-T	California Spray Chemical Co., Richmond, Calif.	40, 58
	New Improved Weedone	butoxyethanol esters of 2,4,5-T and 2,4-D	American Chemical Paint Co., Ambler, Pa.	40, 58
	Pittsburgh Brush Killer Lo-Vol 4	tetrahydrofurfuryl ester of 2,4,5-T	Pittsburgh Agricultural Chemical Co., New York, N. Y.	40, 53-55, 58
	Pittsburgh Brush Killer No. 22	tetrahydrofurfuryl esters of 2,4-D and 2,4,5-T		
	Pittsburgh 10-20 Brush Killer			
	Stantox Brush Killer 22	isopropyl esters of 2,4-D and 2,4,5-T	Standard Agricultural Chemicals, Inc., Hoboken, N. J.	40, 53-55, 58
	Stantox T45	isopropyl ester of 2,4,5-T and amyl ester of 2,4,5-T		
	Stauffer's Brush Killer	esters of 2,4-D and 2,4,5-T	Stauffer Chemical Co., New York, N. Y.	40, 58
	Thompson's Mesquite Killer	tetrahydrofurfuryl 2,4,5-trichlorophenoxyacetate	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	40, 53-55, 58
	Thompson's Bramblecide	pentyl 2,4,5-trichlorophenoxyacetate		
	Thompson's Bramble Weedicide	pentyl 2,4,5-trichlorophenoxyacetate and pentyl 2,4-dichlorophenoxy		

	10-20 Brush Killer	isopropyl esters of 2,4-D and 2,4,5-T	Agicide, Inc., Racine, Wis.	40, 53-55, 58
	2,4,5-T Brush Killer	isopropyl ester of 2,4,5-T		
	2,4-D-2,4,5-T Amine Brush Killer	dimethylamine 2,4-dichlorophenoxyacetate and ethyl amine 2,4,5-trichlorophenoxyacetate	E. I. du Pont de Nemours & Co., Wilmington, Del.	40, 53-55, 58
	2,4-D-2,4,5-T Ester Brush Killer (low volatility)	propylene glycol butyl ether esters of 2,4-D and 2,4,5-T		
	2,4,5-T Ester Brush Killer (low volatile)	propylene glycol butyl ether ester of 2,4,5-T		
	2,4,5-T 43% Ester Brush Killer			
	2,4,5-T 57% Amine Brush Killer	ethyl amine 2,4,5-trichlorophenoxy-acetate		
	Weedanol Brush Killer	esters of 2,4-D and 2,4,5-T	Associated Chemists, North Collins, New York	40, 53-55, 58
	Weedone Brush Killer 32	butoxy ethanol esters of 2,4-D and 2,4,5-T	American Chemical Paint Co., Ambler, Pa.	40, 53-55, 58
	Weedone 2,4,5-T	butoxy ethanol ester of 2,4,5-T		
	Woody Plant Killer	isopropyl esters of 2,4-D and 2,4,5-T	Swift & Co., Chicago, Ill.	40, 53-55, 58
Poison-ivy Killing	Ammate	ammonium sulfamate	E. I. du Pont de Nemours & Co., Wilmington, Del.	6, 41, 46, 58
	Various Names	2,4-D	*Various Companies*	46
Grass Killing	ACP Grass Killer	sodium trichloroacetate	American Chemical Paint Co., Ambler, Pa.	40, 52, 58
	Chipman IPC 25% Liquid	isopropyl n-phenyl carbamate	Chipman Chemical Co., Bound Brook, N. J.	41, 52, 58
	TCA Quack Grass Killer	sodium trichloroacetate	Agicide, Inc., Racine, Wis.	40, 52, 58
Crab Grass Killing	Aero-Cyanate Weed Killer	potassium cyanate	American Cyanamid Co., New York 20, N. Y.	41, 45
	Chipman Sodium Arsenite	sodium arsenite	Chipman Chemical Co., Bound Brook, N. J.	58
	Crabgrass Killer	potassium cyanate	Faesy & Besthoff, Inc., 325 Spring St., New York, N. Y.	41, 45
	Crabgraxx	potassium cyanate	Kelly Agricultural Products Co., McKeesport, Pa.	41, 45
	Crab-Not P.C.	potassium cyanate	Nott Manufacturing Co., Mt. Vernon, N. Y.	41, 45
	Ded-Weed Crabgrass Killer	potassium cyanate	Thompson-Hayward Chemical Co., Kansas City, Mo.	41, 45
	Double-O Crabgrass Killer	potassium cyanate	Doggett-Pfeil Co., Springfield, N. J.	41, 45

Use	*Trade Name*	*Chemical Name*	*Manufacturer*	*Page Reference*
CRAB GRASS KILLING (*Continued*)	Farmrite Crabgrass Killer	phenyl mercuritriethanol ammonium lactate	Central Chemical Corp., Lebanon, Pa.	
	Greevers Crabgrass Killer	potassium cyanate	Greevers, Inc., Chilhowie, Va.	41, 45
	PC 80 Crabgrass Killer	potassium cyanate	Garden Products Co., St. Louis, Mo.	41, 45
	PMAS	phenyl mercuricacetate	W. A. Cleary Corp., New York 1, N. Y.	44
	Puraturf Crabgrass Killer	phenyl mercuritriethanol ammonium lactate	Gallowhur Chemical Corp., New York, N. Y.	44
	Scutl	phenyl mercuric acetate	O. M. Scott & Sons, Marysville, Ohio	41, 44
	Sel-Tox	phenyl mercury monethanol ammonium acetate	Nott Manufacturing Co., Mt. Vernon, N. Y.	44
	TAT-C-Lect	N-phenylmercuriethylene-diamide	O. E. Linck Co., Clifton, N. J.	44
	Weedanol Cyanol	potassium cyanate	Associated Chemists, North Collins, N. Y.	41, 45
	Weedone Crabgrass Killer	potassium cyanate	American Chemical Paint Co., Ambler, Pa.	41, 45
	Zotox	sodium arsenite	Chipman Chemical Co., Bound Brook, N. J.	58
KILLING ALL VEGETATION	Acme Weed Killer	arsenic trioxide	Acme White Lead & Color Works, Detroit, Mich.	
	Ammate	ammonium sulfamate	E. I. du Pont de Nemours & Co., Wilmington, Del.	6, 41, 46, 58
	Atlacide	sodium chlorate	Chipman Chemical Co., Bound Brook, N. J.	
	Borascu	sodium borate one	Pacific Coast Borax Co., New York, N. Y.	
	Concentrated Borascu			
	Chipman Chlorax Liquid	sodium chlorate and sodium metaborate	Chipman Chemical Co., Bound Brook, N. J.	40, 58
	Chipman Chlorax Spray Powder			
	Chipman General	dinitro-O-secondary butyl phenol		
	Chipman Sodium Arsenite	sodium arsenite		
	CMU Weed Killer	chlorophenyl 1, 1-dimethyl-urea	E. I. du Pont de Nemours & Co., Wilmington, Del.	
	Crabex	arsenic trioxide	Rose Manufacturing Co., Beacon, N. Y.	
	D & P Weed Killer	sodium arsenite	Dogett-Pfeil Co., Springfield, N. J.	58
	Dow General Weed Killer	dinitro-O-secondary butyl phenol	Dow Chemical Co., Midland, Mich.	40, 52, 58
	F&B Weed Killer	sodium arsenite	Faesy & Besthoff, Inc., New York, N. Y.	58

	Weed Killer			
	Knoxweed 55 Contact Weed Killer	dinitro-O-secondary butyl phenol	Stauffer Chemical Co., New York, N. Y.	40, 58
	Penta-Kill	pentachlorophenol	Thompson-Hayward Chemical Co., Kansas City 8, Mo.	58
	Polybor-chlorate	sodium borate and sodium chlorate	Pacific Coast Borax Co., New York, N. Y.	
	Sinox General	dinitro ortho secondary butyl phenol and dinitro ortho amyl phenol	Standard Agricultural Chemical Co., Hoboken, N. J.	40, 52, 58
	Sinox W	ammonium dinitro ortho secondary butyl phenol		
	Sinox	sodium dinitro ortho cresylate		
	Sodium arsenite	sodium meta arsenite	Thompson-Hayward Chemical Co., Kansas City 8, Mo.	40, 52, 58
	TCA	trichloroacetate		
	Thompson's Penta Weedicide	pentachlorophenol butyl 2,4-dichlorophenoxy-acetate	Thompson Horticultural Chemicals Corp., Los Angeles 27, Calif.	58
	Thompson's Phytocide	pentachlorophenol		
	Triox	arsenic trioxide	California Spray Chemical Co., Richmond, Calif.	
	Zotox	sodium arsenite	Garden Products Co., St. Louis, Mo.	58
PRESEEDING STERILIZATION OF SOIL	Aero Cyanamid Special Grade	calcium cyanamide	American Cyanamid Co., New York 20, N. Y.	
PRE-EMERGENCE WEEDING	Aero Cyanamid Special Grade	calcium cyanamide	American Cyanamid Co., New York 20, N. Y.	
	Aero Sodium Cyanamid (X-5)	mono sodium cyanamide		
	Dow General Weed Killer	dinitro-O-secondary butyl phenol	Dow Chemical Co., Midland, Mich.	40, 52, 58
	Weedar 64	alkanolamine salt of 2,4-D	American Chemical Paint Co., Ambler, Pa.	40, 51

John Kieran autographing books at the Garden's benefit party.

Harold Swahn

WITHIN THE BROOKLYN BOTANIC GARDEN

AN EVENING WITH JOHN KIERAN

"Spring is a Picnic" was John Kieran's topic at the Garden's benefit party on the evening of April 17. The title gave Mr. Kieran liberty to ramble delightfully through "spring," recounting his experiences and giving his views on different aspects of the season. Following the talk, he answered a round of questions.

The event was arranged to coincide with the publication date of Mr. Kieran's new book, "An Introduction to Wild Flowers" (Hanover House). This book was illustrated by Tabea Hofmann, well known to friends of the Garden. After the talk and questions in the auditorium the 350 guests adjourned to the rotunda where Mr. Kieran graciously autographe copies of his new book, and of his earlie books "Footnotes on Nature" and "A Introduction to Birds."

Special outdoor lighting of the mag nolia trees and the daffodils, which wer in full bloom, lured guests out into th warm spring evening.

For those who missed the benefit party autographed copies of Mr. Kieran's book may be ordered through the Garden.

D. G. H.

CHERRY BLOSSOM FESTIVAL

Greer Garson crownii Cherry Blossom Que Marie McAvoy at t Garden on May Da

Ted Kell, New York Herald Tribune

BROOKLYN BOTANIC GARDEN

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To reach the Garden:

By Subway: from Manhattan, twenty-five to thirty minutes' ride from Times Square or Grand Central.

I.R.T., West Side (7th Avenue or Broadway-7th Avenue line), downtown express marked "New Lots Avenue" or "Flatbush Avenue," to Eastern Parkway-Brooklyn Museum Station.

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From Manhattan, take Manhattan Bridge, follow Flatbush Avenue Extension and Flatbush Avenue to Eastern Parkway; follow the Parkway to Washington Avenue then turn right.

BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

SUMMER
1952

Pruning
Ornamental
and
Fruit-bearing
Shrubs
and
Trees

NEW SERIES
8 NO. 2

AMONG THE CONTRIBUTORS TO THIS ISSUE

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THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
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BROOKLYN 25, NEW YORK
TELEPHONE: MAIN 2-4433

Summer 1952

No tree or shrub that grows is immune from the need of periodic runing. Each year more and more people question the Botanic Garden taff about how and when to prune. The query usually concerns a articular kind of plant, but it is clear that amateur gardeners and orticulturists everywhere are hungry for more information on the undamentals. Our answer is this HANDBOOK ON PRUNING.

To insure authoritative treatment of the subject, we invited rofessor H. B. Tukey, Chairman of the Department of Horticulture at ichigan State College, to be our Guest Editor. He has had the warm ooperation of the many well-informed authors whose material is presented here; it is a pleasure to welcome them to these pages. Readers ay be interested in knowing that Dr. Tukey was one of the group riginally consulted when the Botanic Garden was considering a semi-opular publication in the field of Ornamental Horticulture.

Now back to the subject of pruning:

Properly pruned, a tree will outlast a human lifetime — sometimes any lifetimes. In the natural course of events, trees take care of heir own pruning. Look toward the sky in any mature forest - whether ine, oak, or redwood, and whether two hundred or two thousand years ld. Not a branch will there be for 75 or 100 feet above the ground; et no saw has cut them — man has not intervened. Nature has done he job by shading the lower limbs, which ultimately die and fall to he ground. The wounds heal and the giant trunks tower upward as ingle majestic columns. But this self-pruning technique is successul only where there is a dense stand of trees.

In the home garden there is no substitute for skillful pruning on he part of the gardener. Pruning should be started when trees are oung; and if this practice is kept up faithfully, tree surgery will ever be needed. It is not necessary to prune for conventional ymmetry; there is an increasing interest in "character" pruning — o give special effects, such as that of windswept growth, or age. But more about this in a later issue.

An example of how not to prune is provided by a devoted gardener who has always prided himself on keeping all sucker growth out of his shrubs. After twenty-five years these plants have clusters of trunks like trees. The blossoms are sparse, out of reach, and almost out of sight. The plants are no longer shrubs; instead of keeping them young by continually cutting out the old wood, this gardener has made the mistake of pruning out the young branches as rapidly as they appeared, and has aged his collection to the point where it no longer serves its original design.

Such mistakes and others commonly made by the amateur can be avoided by making this Handbook on Pruning a frequently consulted guide to better gardening.

Sincerely,

George S. Avery, jr.

Director

PLANTS & GARDENS

Kerria japonica

VOL. 8

Summer, 1952

No.

CONTENTS

COVER.—A saw that cuts when pulled. When supporting oneself in a tree, one gets more leverage
pulling than by pushing a saw. *Courtesy American Fruit Grower.*

Pag

Among the Contributors to this Issue .... Page 2 of Cover
Director's Letter 11
The Mechanics of Pruning .... Eldon S. Banta 11
Pruning Deciduous Shrubs and Certain Trees .... A. M. S. Pridham 11
Trimming Hedges .... Donald Wyman 12
Rose Pruning .... Roy E. Shepherd 13
How to Prune, Pinch, and Disbud Chrysanthemums .... Vincent R. DePetris 13
How to Prune Broad-leaved Evergreens .... Henry T. Skinner 13
Proper Pruning of Narrow-leaved Evergreens .... G. William Longenecker 13
Evergreen Trimmings in Window Boxes .... H. B. Tukey 14
Shade Tree Pruning .... William B. Love 14
Root and Top Pruning in Transplanting .... William B. Love 14
Root Pruning .... F. L. O'Rourke 15
Tomatoes and Cucumbers Grown on the Garden Fence .... James H. Burdett 15
Pruning Bramble Fruits .... A. S. Colby 15
How to Prune Currants and Gooseberries .... A. S. Colby 15
Some Principles of Pruning .... H. B. Tukey 16
Wedge Pruning of Fruit Trees .... H. A. Cardinell 16
Thin-wood Pruning of Fruit Trees .... H. P. Gaston 16
Summer Pruning .... H. B. Tukey 16
Fan-style Pruning .... H. A. Cardinell 16
The Production of Flower Buds by Trees and Shrubs .... E. J. Rasmussen 16
Rejuvenating Grafted Plants 17
Within the Brooklyn Botanic Garden 17

H. B. TUKEY, *Guest Editor*
HESTER M. RUSK, *Associate Editor*

Except where otherwise credited, photographs by Louis Buhle

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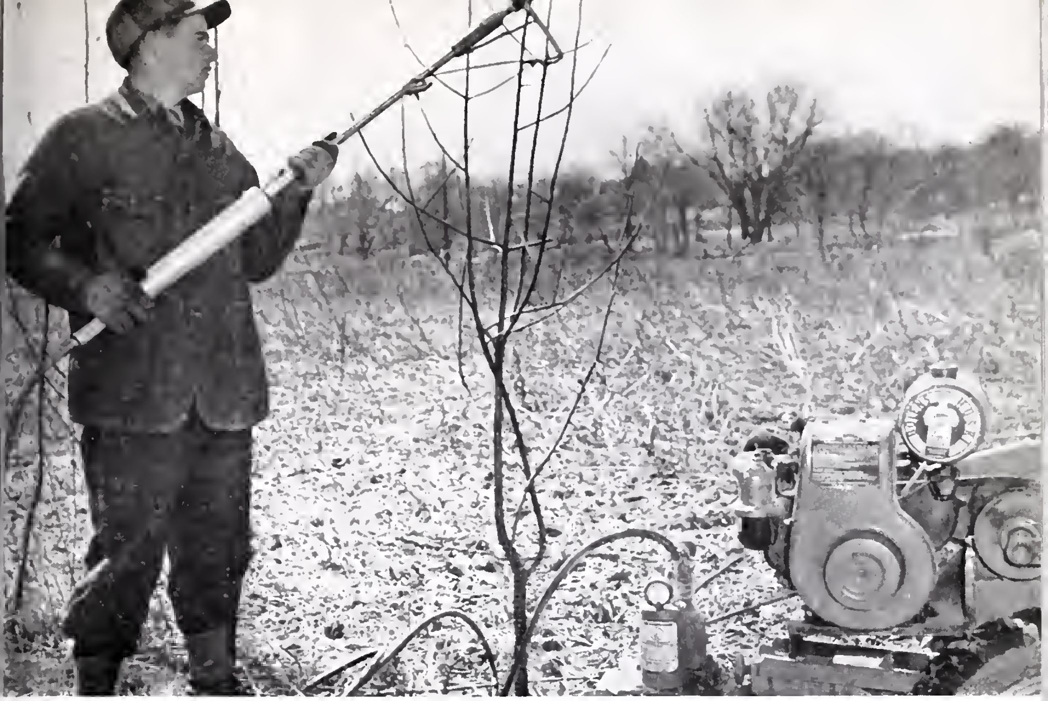


Photos author courtesy

Pneumatic (compressed air) pruner; between 75 and 100 pounds pressure from portable air compressor.

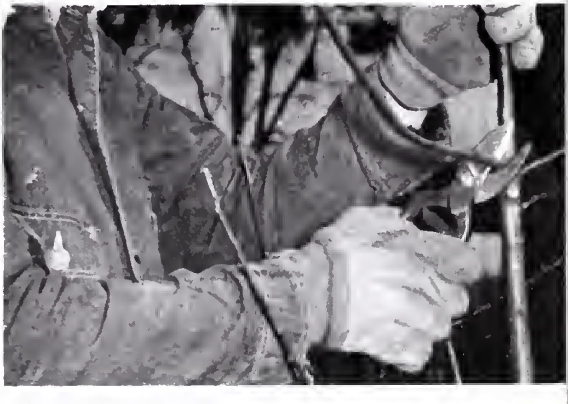
THE MECHANICS OF PRUNING

How to select, care for, and use the proper tools, to obtain the best results

Eldon S. Banta

THE pruning of woody plants is generally considered to be an art or a science or both; it has a mechanical aspect too. Pruning means cutting, and cutting requires tools. The care and proper use of cutting tools are most important to a successful job.

Pruning a branch from a tree, shrub, or vine leaves a wound, just as amputations leave wounds on animal bodies. As there are right and wrong ways to make amputations, so there are right and wrong ways to make pruning cuts. Wounds from properly made cuts heal more rapidly than those from improper cuts. In fact, a tree pruned carelessly is usually short-lived.



Hand pruner held so as to make a close smooth cut.

Author courtesy

Lopping shears for cutting limbs up to 1½ or 2 inches in diameter.

Making the Cuts

Good pruning cuts are those that lea a clean, smooth surface on the wound: stub should remain; no split branches torn bark should be left. When a bran is cut off smoothly, close to the ma branch, the wound heals quickly.* A that leaves a stub, or ragged edges, bark split down the side, leaves a pla for rot organisms to enter and do th damage before healing of the wou takes place. A heavily pruned plant m have a number of wounds; and if rot gins in several of them, the plant m live only a few years; at best it will unsightly.

The time to prune may be conside partially within the realm of pruni mechanics too. With several species trees, scientists have discovered t wounds form **callus** and heal faster fr cuts made between February 15 and M 15 than at any other time of the ye They have also discovered that woun made on the trunk or lower branches a

---

*Illustration on page 146.—Ed.

Long-armed hand pruner.

Courtesy American Fruit Gro

those made close to the main stem or trunk heal faster than wounds farther out on limbs and branches. Hence the larger cuts on main branches should be made as close as possible to the center of the tree. In other words, if there is a choice of making a cut on a main lateral branch 2 feet or 4 feet from the trunk, the wound will heal faster at the 2-foot mark.

Dressing Pruning Wounds

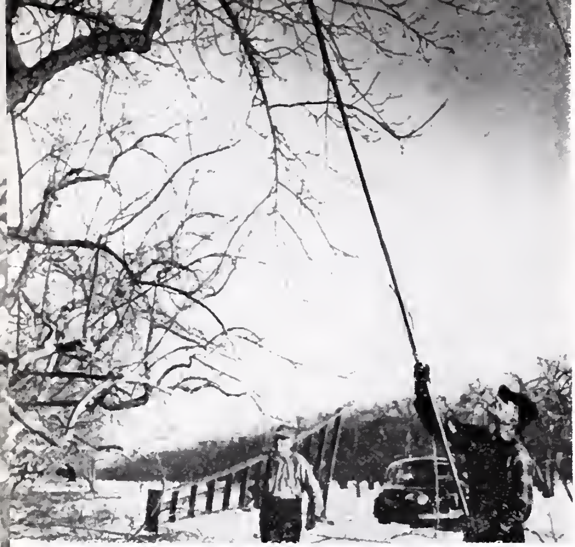
Pruning wounds less than 2 inches in diameter are rarely treated or dressed. There is some question of the great value of dressing even larger wounds if they are made properly. An improper dressing compound could greatly reduce the rate of healing or even prevent healing entirely. Compounds with an asphalt base have proved best, and several appear on the market. The use of any wound dressing that contains turpentine, coal tar, or common paints should be avoided, as these materials injure the growing tissue and slow the healing process.

Courtesy American Fruit Grower

Double-edged saw for pruning limbs 2 inches or more in diameter.

Lopping shears for removing larger branches of shrubs.

Author courtesy



Author courtesy
Pole pruner for limbs 12 to 15 feet high and 1 to 1½ inches in diameter.

Electric clipper for quick trimming of hedges.

Pole saw for cutting small branches without climbing.

Choice and Care of Tools

The major mechanical problem of pruning lies in the choice of tools and equipment. No one can tell anyone else which type of saw or pruning tool he will like best. Each person will probably try several before he finds the one he will choose. However, some help toward this decision may be found in the accompanying illustrations of pruning tools and how to use them; they might furnish a new idea. While these illustrations are largely of fruit plants, the principles represented are applicable to most of the trees and shrubs in our landscapes.

To maintain pruning tools in good cutting condition is an essential part of pruning. After use, all tools should be cleaned and their cutting surfaces wiped with an oily cloth to prevent rust. Saws kept in good set with sharp even teeth do a smooth cutting job—an objective of a skilled pruner.

Pruning is an interesting horticultural practice, and the care and use of the tools is an especially worth-while part of it.

←

Two edged power clipper, equally effective for top and for side trimming.

McFarland

Lilacs bloom profusely when properly pruned.

PRUNING DECIDUOUS SHRUBS AND CERTAIN TREES

Explanation of basic practices and the purposes for which they are used. Lists of plants needing different kinds of treatment

A. M. S. Pridham

WOODY plants as well as herbaceous ones are used in landscape gardening for two very important reasons: first, their beauty, and second, their utilitarian value for screening, hedging, shade, and climate control. The gardener is thus faced with a series of compromises. The natural beauty and health of the individual plants are paramount; but the plants must also be kept within reasonable limits of size or they will become out of scale with their surroundings or perhaps interfere with the use of roads, paths, doors, or windows.

Sanitary Pruning

Above all, plants should be kept in a healthy vigorous condition. Thus, the **removal of dead limbs** becomes an obvious pruning procedure once growth has started in the spring, when live branches can readily be distinguished from dead ones. The primary cause of unhealthy growth should be determined and corrected, whether it is disease, or climate or soil conditions.

Examples

Some common shrubs (and certain trees) that require frequent removal of dead or diseased branches (*sanitary pruning*) are named below.

glossy abelia	*Abelia grandiflora* hybrids
peach, nectarine, and almond	*Amygdalus* section of *Prunus*
butterfly-bush	*Buddleia* hybrids
trumpet-vine	*Campsis radicans*
flowering quince	*Chaenomeles*
clematis	*Clematis*
cotoneaster	*Cotoneaster*

slender deutzia	*Deutzia gracilis*
hills-of-snow	*Hydrangea arborescens grandiflora*
drooping leucothoe	*Leucothoe catesbaei*
privet	*Ligustrum*
holly mahonia	*Mahonia aquifolium*
apple	*Malus*
photinia	*Photinia villosa*
stone-fruits	*Prunus*
firethorn	*Pyracantha coccinea*
pear	*Pyrus communis*
rose	*Rosa* hybrids
Thunberg spirea	*Spiraea thunbergi*

Three Main Practices

Thinning out, heading back, and renewal pruning are three fundamental procedures for the manipulation of shrub growth to conform to the purpose for which a shrub is grown.

Thinning implies pruning the entire branch back to its point of origin on the parent stem, which may be a large branch or the main trunk of a tree, or one of the main stems of a shrub.

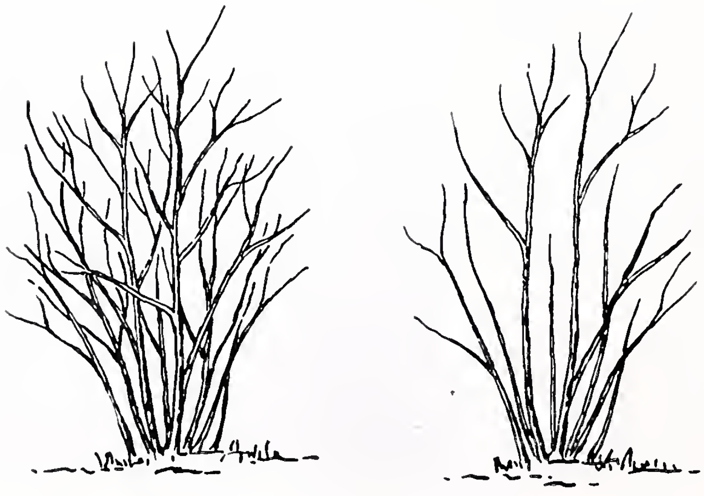
Heading back means the removal of only the terminal portion of a branch; usually the cut is made just above a bud or a small side branch.

The effect of pruning a stem is to modify growth adjacent to the cut. Removal of the terminal bud or the terminal portion of a stem stimulates the growth of dormant or quiescent side buds on the remaining part of the branch. Growth stimulated by pruning is often vigorous and may or may not be desirable. Heavy pruning implies the removal of about half (or more) of the stems by cutting back into older wood. Such pruning is likely to result in excessive stimulation of dormant buds, followed by the growth of large numbers of new but weak stems (often five or more) from the vicinity of each pruning wound.

Renewal pruning. Heavy pruning of a few main stems to the ground or of a few branches to the main stem is sometimes done to renovate old plants or to maintain vigorous healthy growth in mature shrubs. Such procedure is commonly called renewal pruning.

Structural Pruning

Narrow crotches. Woody plants that are prone to weak, narrow crotch formation need pruning to improve their natural structure. The resistance of leafy twigs to strong wind and rain, or the weight of ice on branches tends to cause splitting of the narrow-crotched limbs in



Shrub before and after thinning out.

trees and shrubs with weak or brittle wood.

The structure of such plants can be improved by thinning out certain branches and heading back others. In this way occasional weak crotches can be eliminated and a poor natural growth habit can be modified somewhat for the better. Heading back one branch of the pair forming a narrow crotch tends to slow up the growth of the pruned member; this reduces its mass to that of a side branch rather than permitting it to remain as a competing member of a pair.

The position and distribution of main limbs are important for strong growth and can be regulated by structural pruning of stems. On many flowering shrubs, as well as on shade and fruit trees, structural pruning should be done early in the life of the plant. Vigorous twigs may be selected for growth into scaffold branches and the remainder of the twigs thinned out. Scaffold branches (the main branches that form the framework of the tree) may be three to five or more in number, distributed around the trunk in approximately regular fashion; they may well arise at different levels, 6 to 12 inches apart along the trunk, to avoid undue stress at any one point.

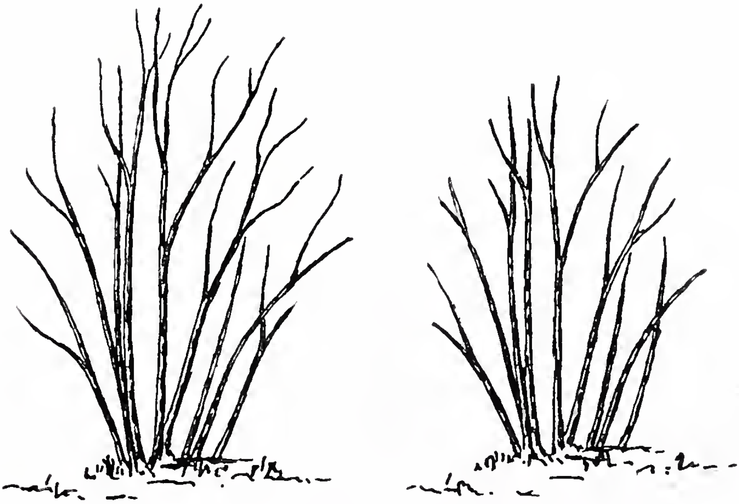
The relatively uniform spacing of the main stems of a shrub or the major branches of a tree permits even penetration of sunlight and encourages vigorous growth of scaffold and flowering branches. Less vigorous twigs, competing branches, and malformed ones are thinned out along with dead ones.

Structural pruning should begin in the nursery and is the major pruning needed at the time of planting. It should be of first concern for the early years of growth after a young plant becomes established in a garden.

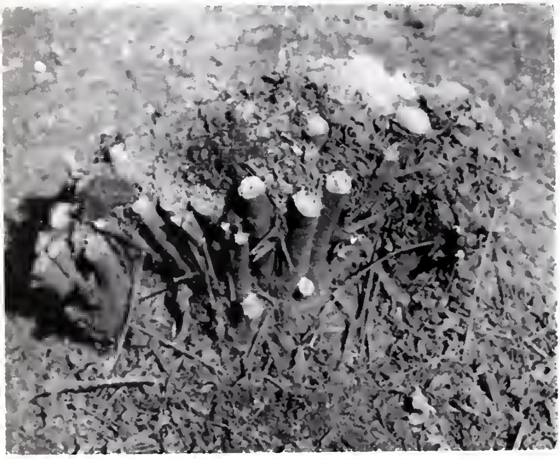
Examples

Some common shrubs (and certain trees) that are weak in wood or structure and need corrective pruning are given here.

Amur maple	*Acer ginnala*
silver maple	*Acer saccharinum*
smoke-tree	*Cotinus coggygria*
wahoo, or burning-bush	*Euonymus atropurpureus*
Tatarian honeysuckle	*Lonicera tatarica*
apple	*Malus*
Lombardy poplar	*Populus nigra italica*


Shrub before and after heading back.

Beauty-berry (*Callicarpa*). Old shrub in need of renewal pruning.



Above: Severe heavy-pruning (shrub completely cut back) to stimulate new growth.

Below: Shrub in prime condition with all new growth, two years after severe heavy-pruning. Different shrubs in the same row should be cut back in different years.

stone-fruits	*Prunus*
staghorn sumac	*Rhus typhina*
willow	*Salix*
Chinese lilac	*Syringa chinensis* hybrids
American elm	*Ulmus americana*

Restrictive Pruning

Restricting the size to which specimen and other plants grow is a rather vexing problem that sooner or later faces every gardener.

Restriction in size of shrubs can be accomplished by heading back the young growth of vigorous twigs. This helps to retain the normal shape of the plants; but as time goes on, compact growth builds up and the effect becomes that of a sheared plant. Slow-growing plants such as the dwarf European cranberry-bush (*Viburnum opulus nanum*) can be restrained for a number of years with relatively little work.

Specimen plants, which are grown for their individual beauty of form, generally need little if any pruning beyond the occasional removal of dead branches, and structural pruning.

Artificial shapes. Specimen plants that are limited to artificial shapes, such as standards or espalier or sheared forms, require restrictive pruning. The necessary restrictive pruning is done by thinning out or heading back the growth that is made each year. Summer pruning is often necessary to accomplish restriction of growth. One and possibly three or more prunings are needed each summer to keep such artificial forms in presentable condition. This requires work at rather specific and critical times.

Shearing to irregular shapes can be done, with persistence, but it requires willingness on the gardener's part to follow the irregular pattern once it is established. If one does his own shearing, he may easily produce yew (*Taxus*) specimens that have the attractive irregularity of outline often found in old boxwood.

Severe restrictive pruning can be done without undue detriment to shrubs; the ops can be cut off 3 to 6 inches above he ground. The pruning back may be lone in late fall and is often a useful rocedure to prevent snow from drifting n driveways or to facilitate removal of now from roads or walks. Vigorous vergrown shrubs may be renovated by evere pruning followed later by structural pruning.

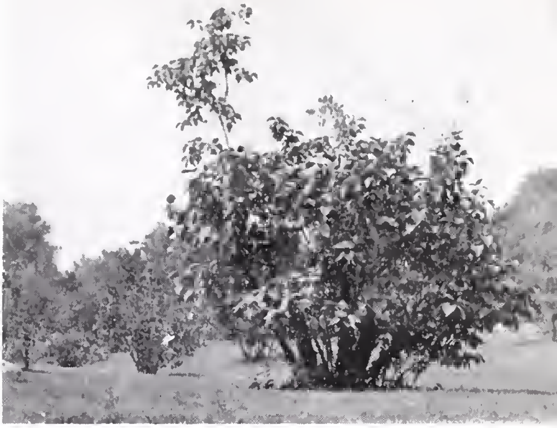
Root pruning tends to restrict plant ize but is seldom practiced.

Transplanting is more effective because ll roots are cut in the process. Growth f larger shrubs and trees is definitely retarded after transplanting; this is easily shown by comparison with untransplanted controls. Young plants usually become established quickly after transplanting and within three to five years catch up with untransplanted controls. Changes in soil conditions, however, exert strong influence. Occasionally a shrub has sufficient sentimental or artistic value to warrant transplanting in order to retard its growth.

Examples

Following is a list of common shrubs (and certain trees) that tend to become overgrown and often need to be restricted or to have competing plants removed.

Japanese barberry	*Berberis thunbergi*
Japanese quince	*Chaenomeles lagenaria*
red-osier dogwood	*Cornus stolonifera*
fuzzy deutzia	*Deutzia scabra*
spindle-tree	*Euonymus europaeus*
golden-bells	*Forsythia* species and hybrids
beauty-bush	*Kolkwitzia amabilis*
privet	*Ligustrum*
honeysuckle	*Lonicera* species and hybrids
apple	*Malus*
mock-orange	*Philadelphus* species and hybrids
ninebark	*Physocarpus opulifolius*
poplar	*Populus*
sumac	*Rhus*
prairie rose	*Rosa setigera*
American elder	*Sambucus canadensis*
Chinese lilac	*Syringa chinensis* common hybrids


Lilac bush in need of pruning.

Natural Causes of Restrained Growth

Pruning is not the only thing that restrains plant growth.

Early fall frosts and severe winter temperatures exert a distinct dwarfing or pruning effect on many exotic plants and on some native ones.

Summer drought also has a limiting effect on plant growth, though its manipulation is largely impractical for the gardener to undertake.

Compact soils and compact layers in the subsoil mechanically limit root growth just as severely as does a clay pot or a concrete planting pocket, and restricted root growth results in restricted top growth.

Same bush as shown above, properly pruned: practically all of the oldest branches removed to encourage the best of the new growth; tall straggling branch cut off.

McFarland

Catalpa trees (*C. bungei*) give this special effect if headed back yearly.

Modification of Flowering

Pruning is sometimes done to modify flowering, by limiting the number and improving the size of the individual blossoms. In some cases, at least, a large number of flowers is desirable for mass effect. The usual warning to delay pruning until after flowering is based on the idea that the more bloom the better.

Forsythia blooms profusely when properly pruned—flowers on every branch.

McFarland

Pruning of espalier types should be done carefully to assure the presence of enough leaf surface to permit development of satisfactory flower buds; this often means six or more leaves with each flowering spur or lateral twig.

Induction of flowering in young plants is not often accomplished by pruning. While root pruning may lead to flower production under some circumstances, pruning in general is not a practice likely to bring about immediate flower bud formation.

Pruning Wounds

Care of pruning wounds is not to be passed over lightly. However, the use of wound dressing on the majority of shrubs is superfluous. Pruning in late winter or early spring permits small wounds to heal quickly when shrubs are healthy and plenty of leaf buds exist above or adjacent to a pruning wound. Lawn mowers and cultivating tools are likely to cause more damage than pruning wounds. Certainly unnecessary injury is to be avoided, as all wounds are possible roads of entry for disease and insect pests.

Equipment

Pruning equipment is relatively simple, but the danger of accident is rather high. When the use of ladders and mechanical equipment is necessary, it is wiser to hire the work done by competent men who carry insurance to cover personal and property damage. For light jobs the simplest tool possible should be chosen—a sharp knife or hand shears—and leather gloves should be worn. The prunings should be placed in a neat pile on a narrow burlap strip, so that they are out of the way during the work. They can easily be gathered up with the burlap, and the exposed twig ends tied to make a convenient bundle, leaving the burlap strip free and ready for use again.

TRIMMING HEDGES

When and how much to trim various types at different ages and for different purposes

Donald Wyman

THE proper training of hedges starts the day they are planted, for the correct kind of trimming at this time will insure the right type of growth later.

Dense Growth at the Ground

In all types of hedges, it is desirable to have the plants well branched to the ground, so that there will be a dense mass of foliage. However, when the plants arrive from the nursery, some may be grown with single stems, possibly in preparation for sale as specimen plants. Beeches, hawthorns, lindens, and maples might be in this category. Such plants should be ruthlessly cut to within 6 inches of the ground as soon as they are planted. If this is done, they will send out several buds which eventually will be the main branches. Many shrubs like privet, honeysuckle, and euonymus will have several branches at the base and need not be treated so roughly at planting time.

Unfortunately, evergreens do not respond to this type of pruning so readily as do deciduous plants; and so if evergreens are to be used, one must be certain that the plants purchased have many branches at the ground level.

All the pruning for the first year or two should be aimed at making the plants dense and bushy **at the ground.** Often one sees a hedge that has been allowed to start growth with the first few branches several feet from the ground. Such plants rarely will send out branches at the base, and their effectiveness as hedges is curtailed because of this open spot near the base. The only way to force branches to grow there is to cut the plants to the ground and start all over.

Usually it is best to start with plants 3 feet high (or less) because these can be more easily trained than larger plants. The ideal hedge plant is one with many branches from the base and with leaves clothing the branches right to the ground.

An English holly hedge (*Ilex aquifolium*) requires only occasional slight trimming. Photographs show hedge before and after trimming.

Shaping

Most people now recognize the fact that to have the hedge wide at the base and narrow at the top is far better than the reverse. This is important, in order to allow the lower branches plenty of sunlight so that they will continue to bear profuse foliage to the ground. Fast-growing plants like privet can be trimmed with perpendicular sides; but with most other kinds of hedges, it is much safer to trim the plants in such a way that they will be gently rounded in outline, smaller at the top and wide at the bottom.

Many a gardener has vigorous-growing privet in mind when he thinks of trimming. These plants grow so fast that they must be trimmed several times a season. However, not all hedges are like this. There are many that need be trimmed only once each year, and some that need trimming only once every two or three years. It all depends on the age of the hedge, the kind of plant material, and the general purpose for which the hedge is grown.

Deciduous Material

As has already been explained, the deciduous hedge is best cut to within 6 inches or a foot of the ground immediately after planting. The first year of growth the plants are left unmolested in order that they may make the maximum growth. The second year, some may need a heavy pruning, but all of them will most certainly need a pinching back of the branches in order to force lateral growth which makes for density. Especially is it important at this time to keep the terminal shoot or leader restrained. Trees like beech, maple, and sycamore have strong leaders, and these must be checked in order to make the plant become denser at the base. If the leaders are not restrained at this early date, the plant will grow high rapidly but lateral growth (which is necessary for dense foliage, especially at the ground level) will be retarded. The third year of growth, most plants will need a normal trimming.

Evergreens

Evergreens should not be cut back harshly. Hence, the pinching back of terminal shoots is most essential in order to produce lateral growth. Most evergreens have strong leaders, and these must be restrained in order to make the hedge become bushy. Once the small hedge has become fairly well filled in at the base, it can be allowed to grow moderately in height.

How Much to Trim

The amount of growth to trim off de-ends on the kind of plants used and on eir age. For instance, one would ex-ect to trim off more material from a rivet or honey-locust hedge than one ould from a boxwood hedge. If the lants have not reached the height at hich they are to be permanently main-ined, more growth should be left on.

If the hedge has reached the height at hich it will be maintained, it may be rimmed back to within an inch (or less) f the previous year's growth. Even this s impossible to keep up indefinitely, for t is obvious that under this condition he hedge will still enlarge. Sometimes t is necessary to cut back to 2-year-old r 3-year-old wood. One should be very autious in doing this, as some plants ill not respond well to such trimming; ut a little experimenting with the par-icular type of hedge grown, will soon how whether or not this severe pruning an be done. With deciduous hedges, at east, it is usually possible to cut the lants back nearly to the ground level hen they become overgrown, and thus tart a new hedge.

When to Trim

A young hedge that has not yet eached its full height is best trimmed luring the actual growing season in late pring; as elongating shoots are pinched ack, lateral buds are forced into imme-liate growth.

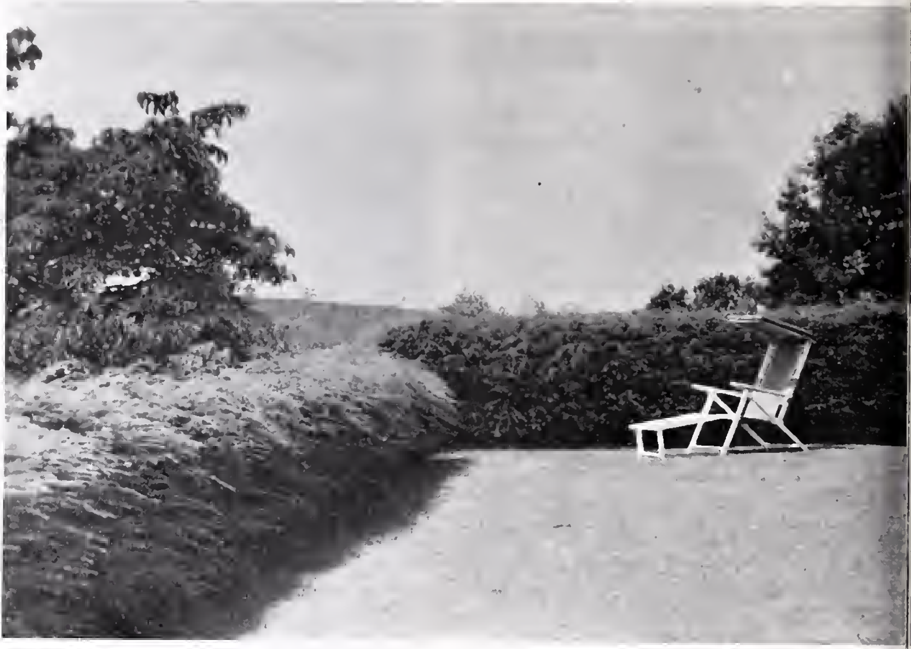
On the mature hedge, trimming can be lone at any time, but during or imme-liately after the actual growing season s best. This is often in late June or ery early July in the northern United States. At this time the growth is over or a period at least, and so one trim-ning will suffice for most or all of the eason.

Then, too, any further growth that is nade will have sufficient time to harden ff before cold weather. If trimming is lone in late July or August (in the north-rn United States) such young growth as s forced out may be too tender and so e killed during the winter, leaving unsightly dead spots in the hedge. Certainly any heavy trimming, especially that done to evergreen hedges, should be done in the spring.

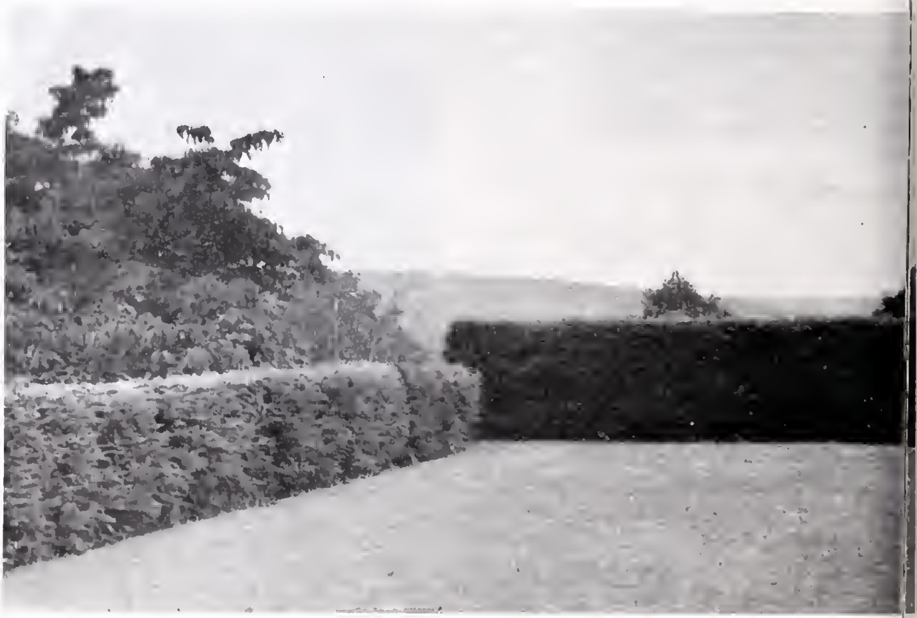
Shaded branches are frequently the least hardy. A heavy fall trimming, re-

Above: Japanese yew (*Taxus cuspidata*)—newly planted hedge.

Below: Same hedge five years later; light trimming has stimulated lateral growth so that hedge has filled in from ground up.

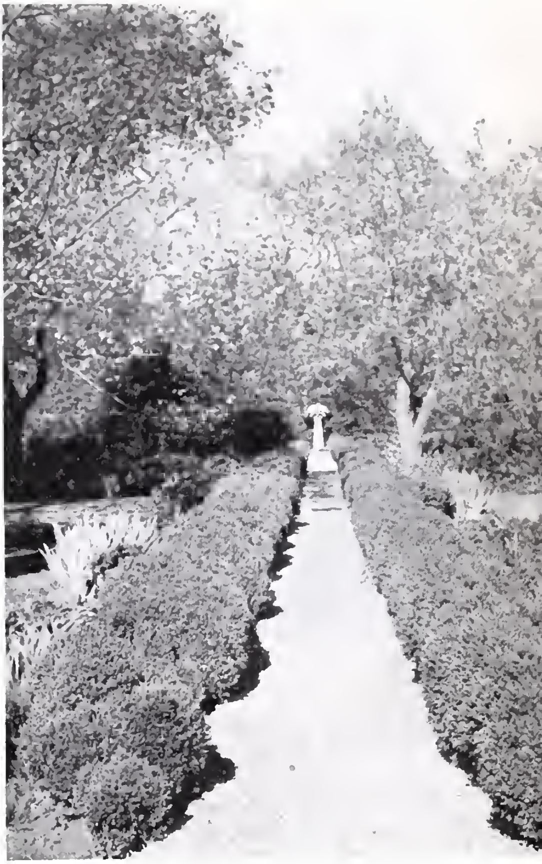


Hemlock hedge (*Tsuga canadensis*) before and after pruning.



sulting in the exposure of a number of shaded branches, might result in serious winter injury to the hedge, whereas the same heavy trimming given in the spring would leave plenty of time for young shoots to grow and harden off properly before winter. The same caution should be taken in heavily trimming a hedge just prior to a long hot dry spell in the summer. Such a trimming had better be advanced a few weeks into late spring in order to allow new growth to develop and shade the most vulnerable spots.

Trimming once at the end of the actual growing season is usually sufficient for all but the most vigorous-growing hedges such as privet, honey-locust and osage-orange. It may be that a few shoots will grow and need trimming here and there before fall, but these will not be sufficient to necessitate a heavy trimming in the fall. In any event, the object of each and every trimming is to remove the terminal buds and so force lateral buds into growth, thus increasing the density of the foliage of the entire hedge.



Low hedge of a dwarf form of the common box (*Buxus sempervirens suffruticosa*).

Photos courtesy Arnold Arboretum

Demonstration of many kinds of hedges, at the Government Station at Ottawa, Quebec, Canada.

McFarland

ROSE PRUNING

Reasons and aims. Methods for various types and for different purposes

Roy E. Shepherd

THE genus *Rosa* comprises shrubs of widely diversified types. Pruning requirements differ according to the kind as well as the hardiness of the individual plant and the purpose for which it is used.

Reasons for Pruning

If we examine a forest tree or a roadside shrub, we see that although Nature prunes mercilessly she follows a certain form or pattern: only those branches that are weak or have outlived their usefulness are destroyed. Nature, however, is interested primarily in efficiency rather than in beauty; and judicious pruning in the garden is often necessary to keep a plant within bounds, to improve its appearance, and to improve the size and form of individual blossoms desired for exhibition.

A shrub is essentially a collection of branches; hence the individual branches must compete with each other for survival. On each of these branches there are several buds, which (if given the opportunity) will eventually develop into additional branches. If these buds were to begin their development simultaneously, there would be more branches than could be accommodated and the plant would become too dense. This condition rarely occurs in the wild but is common where excessive fertilization has been given, and the plant not only becomes less attractive but the numerous individual blossoms lack size and substance.

In most instances the terminal bud of the branch is the most thrifty of all the dormant buds and (under normal conditions) produces the first and fastest-growing shoot. When this occurs the subject soon becomes spindling, as the less vigorous side buds do not receive sufficient nourishment to develop into branches. Corrective pruning is therefore advisable. Another major reason for corrective pruning of roses is that a branch (or cane) begins to die after attaining full size and cannot compete with a healthy growing one in the production of bloom.

Steps in Pruning

Pruning is not a difficult task if done step by step; in fact it is very interesting work. The first step should be the removal of all dead wood; the second, the cutting out of all weak and useless growth; and the third, the shaping of the plant. If all dead, weak, and superfluous growth is removed at the crown of the plant, the desired results can be accomplished in many instances without destroying the natural growth habits of the specimen.

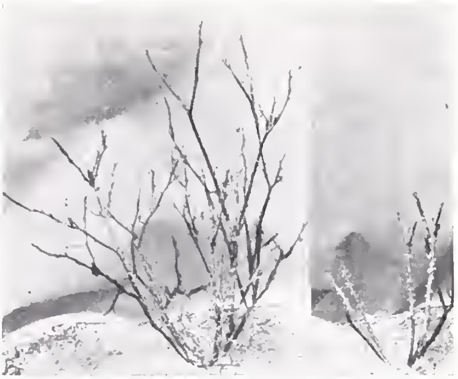
What has been said so far applies primarily to those varieties that do not lose a major portion of their wood through winter injury, namely the species roses, the hardy old-fashioned types, and many of the climbers and ramblers.

At the time of planting, all roses, regardless of variety or type, should be cut back severely; but after they have become established, the various classes should be handled differently.

Methods for Different Types

In the **shrub and species roses** pruning should be confined to the cutting out of dead and very old wood and the shaping of the plant. The grace and beauty of these types can easily be destroyed if they are pruned too severely.

The large-flowered climbers such as DR. W. VAN FLEET bloom on new wood that grows from the older canes; pruning of these roses should be limited to the removal of unwanted growth.



Hybrid tea rose, before and after pruning. For a large number of flowers, four or more buds are left on each cane.

Climbers or ramblers of the CHEVY CHASE **type** are best pruned immediately after blooming, as they produce blossoms mostly on new wood; the removal of all old canes at their bases encourages the growth of new and vigorous shoots.

All members of the **Hybrid Tea, Hybrid Perpetual, Polyantha,** and **Floribunda** classes should be cut back moderately to severely each spring, since the wood is short-lived. Although serious winter injury may not have occurred, more and better blossoms will be produced on new wood than on old wood that has outlived its usefulness.

Hybrid Teas. There is some disagreement among experienced rose growers as to the comparative value of long and short pruning in the spring; but there is unanimous agreement that Hybrid Teas should be pruned severely (to two or three buds) if exhibition-quality blossoms are desired, and less so (four or more buds) if quantity rather than quality is the objective.

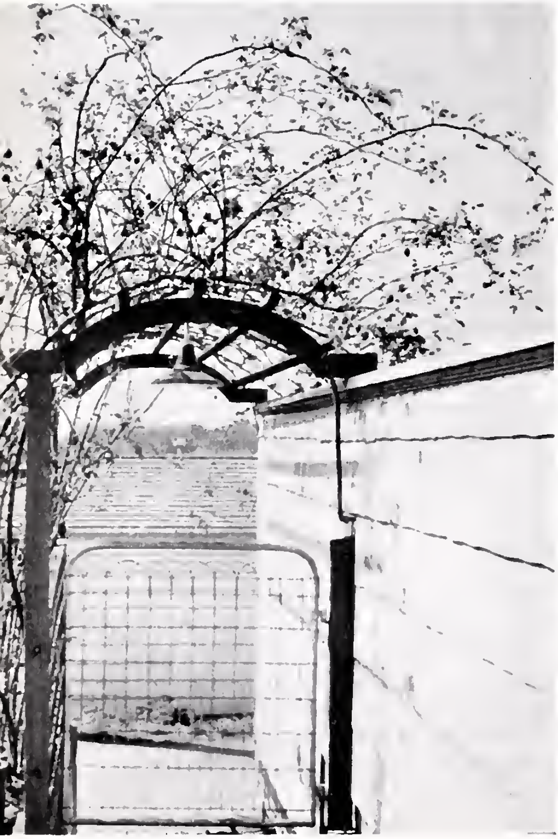
As we reduce the amount of wood we also reduce the number of buds, and the energy of the bush is directed into a few rather than into many buds. The result is that the blossoms (though fewer) are larger, and the plant is more thrifty.

Beneficial midsummer pruning of the so-called *remontant* (*everblooming*) roses is automatically accomplished if the blossoms are cut properly. There are ordinarily several buds along the average stem (at the bases of the leaf stalks) and each bud is capable of producing a shoot; it is therefore apparent that only one, two, or possibly three should be permitted to grow if large blossoms are desired. The production of many shoots will result in inferior blossoms, and occasionally in a complete lack of blossoms, inasmuch as the production of wood is made at the expense of bloom. The buds and shoots near the base are the most valuable; and so if the plant is to be well shaped, the flower stem should be cut with moderation. It should be sufficiently long to permit proper balance between the blossom and stem but not so long as to remove an excessive amount of necessary foliage. Leaves are vitally important to the future health and vigor of the plant.

Hybrid Perpetual roses occur in several types, which differ greatly in habit of growth, production of flowers, and hardiness; and all of them should be pruned less severely than the Hybrid Teas. From 8 to 15 inches is the ideal height for most varieties when exhibition-type blossoms are desired; and from 20 to 25 inches, when the objective is garden display.

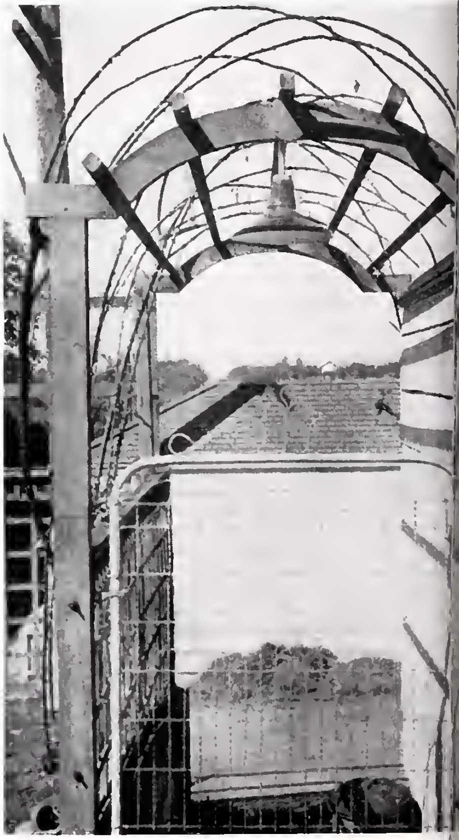
Polyanthas and Floribundas. As the value of these roses depends mostly on the mass of bloom rather than on the quality of the individual blossoms, the pruning should consist only in the removal of dead, old, or diseased branches and the shaping of the plants.

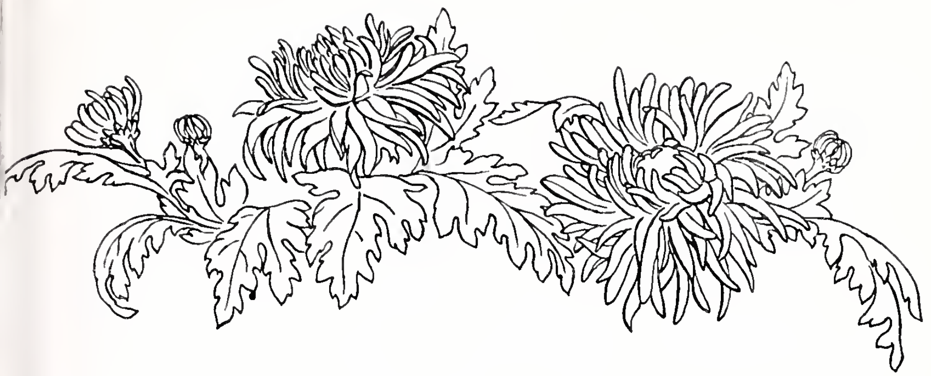
Climbing rose in need of pruning.



Same rose after pruning

Photos courtesy American Rose Annual





HOW TO PRUNE, PINCH, AND DISBUD CHRYSANTHEMUMS

To produce the best effect, according to the variety—to strengthen the plants, to induce branching of the stems and proper spacing of the flowers, or to produce flowers of maximum size

Vincent R. DePetris

THE production of high-quality blossoms on chrysanthemums depends to a great extent on the skillful pruning, pinching, and disbudding of the plants during the growing season. Not only must these operations be performed with expert knowledge but they must conform to the type and habit of each particular variety and must be properly timed if the final results are to be satisfactory.

Pruning

Pruning consists in **removing weak growths** which might never produce good flowers, and thus channeling the growing vigor to the stronger stems which will ultimately produce the best blossoms. Pruning of weak stems also permits a greater circulation of air, thus preventing diseases which would result from undue crowding.

Pinching

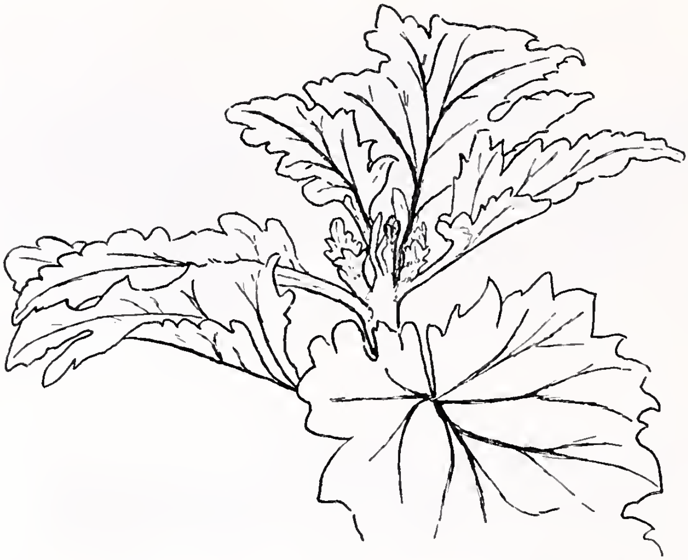
Pinching denotes the removal of the soft growing tips of the strong stems during early summer.

The purpose of pinching is two-fold. In the first place it induces the plants to send two or more **branches** where only one would have developed. It is obvious therefore that only the strongest shoots should be pinched, since pinching weak shoots would produce still weaker growths which never produce saleable sprays of flowers.

The second purpose of pinching is to help produce **more perfectly spaced sprays** on stems that are neither too long nor too short. Too short stems result in a bunched effect of the individual flowers at the terminus of the branch.

From the foregoing it can be seen that judicious pinching of pompons not only increases the yield in terms of the number of stems but also produces sprays artistically formed for decorative use.

Timing of the pinching process is important, so that chrysanthemums grown for sprays of cut flowers are not pinched too late in the season. With the shortening of the summer days flower bud inception is taking place. The time of final pinching depends therefore upon the



Drawings courtesy Ernest L. Sco

Crown bud (in middle) with a leaf bud on each side.

final blooming date of each variety. Generally speaking, the final pinch for pompons and spray varieties should take place about ninety to ninety-five days before the blooming date of each variety.

Disbudding

Disbudding is practiced on plants that are to produce but **one flower** to a stem. To be effective, it must be done on varieties that produce **large** flowers. It would be senseless to disbud small or button pompons or small single daisies, since the increase in size in the small-flowering types would be negligible.

Disbudding therefore is practiced only on **large-flowered** chrysanthemums, frequently called standards, and on large anemone and daisy types, as well as on the Japanese threadlike varieties. If flowers of maximum size are to be obtained, it is essential that the right bud be *taken* (as it is technically expressed) at the right time.

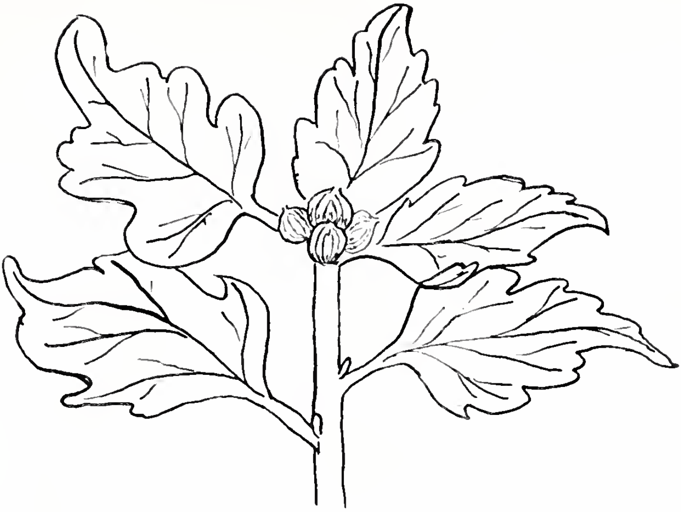
Three types of flower buds are produced by chrysanthemums at different stages of their growth cycle.

The first crown bud is the name give
to the first flower bud produced; it a
pears generally in late June. This bu
is always removed.

A second crown bud appears about
month later, or sometime in late Jul
depending on the earliness or lateness c
the variety. Both crown buds are sol
tary and are accompanied by growin
(vegetative) shoots. To produce the ve
largest blossoms, the second crown bu
is reserved (or *taken*) in late July c
early August on exhibition varieties.

Terminal buds. If the second crow
bud is removed, a final *cluster of buds* wi
appear in late August or early Septembe
These are called "terminal" buds—whi
means that they are the last buds pr
duced. Terminal buds may be disti
guished by the fact that there are sever
of them in a cluster without any veget
tive growths. The largest and bes
placed terminal bud must be reserv
(*taken*) for development, since no mo
buds will appear on the plant.

Terminal buds produce smaller blo



Cluster of terminal flower buds, with no leaf buds.

soms with fewer petals, but always produce flowers of more intense color.

What has been said regarding buds of large-blooming, incurving, and reflexing varieties applies also to large anemones and daisies as well as to the threadlike varieties. Most of the threadlike varieties have weak stems and this tendency is accentuated when crown buds are reserved. Therefore unless the variety is known to produce strong stems crown buds should not be selected.

Tall slender chrysanthemums, not pinched.
Photos author courtesy

Low bushy plants, pinched three months before blooming time (terminal growth snipped off when plants were 2 to 3 inches tall).

HOW TO PRUNE BROAD-LEAVED EVERGREENS

To shape them for year-round decorative effect, and to encourage flowering and fruiting

Henry T. Skinner

THE term "broad-leaved evergreens" brings to mind such plants as rhododendrons and mountain-laurel, hollies, cherry-laurel, evergreen privets, and the berry-bearing bushes such as evergreen
barberries and mahonias, evergreen v
burnums, cotoneasters, and firethorns.

Because broad-leaved evergreens ar
grown as much for their form and al
year decorative effect as for season
flower or fruit, pruning (when nece
sary) consists in little more than an o
casional formative shaping. At long i
tervals a more drastic restriction may b
necessary, to correct the spindling ind
vidual. With the exception of rhododen
drons, most evergreens tolerate sever
and regular pruning where formal effec
are desired; but this kind of prunin
is not dealt with here.

Rhododendrons

Healthily growing rhododendrons, t
gether with their allies the mountai
laurel and andromeda (*Pieris*), need ve
little pruning aside from the regular r
moval of flower clusters as soon as t
flowers have faded. By preventing se
formation this removal encourages t
growth of side shoots and the develo
ment of a full and compact bush.

Old rhododendron, in need of pruning
stimulate new growth at base.
Author court

Under conditions of heavy shade or old age the plants may sometimes become spindling regardless of care. Such plants can be severely pruned to promote the growth of new basal shoots as replacements for the old spindling trunks.

The best time to do pruning of this sort is in late winter, in the month of March. One or two of the heaviest trunks may be cut back to a side branch close to the ground and new branches will break out during the following growing season. Some gardeners prefer to bend these heavy limbs over and tie their ends to a stake the year before pruning is contemplated. This act of bending induces basal shoot production perhaps a little more easily, but it is not really necessary. Rhododendrons collected in the wild by nurserymen are commonly cut off almost at growth level before transplanting, and recovery is rapid.

A milder form of top pruning can be practiced on mountain-laurel or rhododendrons that are growing a little too large for their position. In this case all that is necessary may be the removal of a few of the larger branches, cut to a good side shoot at the base. Such restriction *can* be done after flowering, in early June; but as a general rule it is better to sacrifice a few flowers and be sure of new growth replacement by pruning during the dormant season.

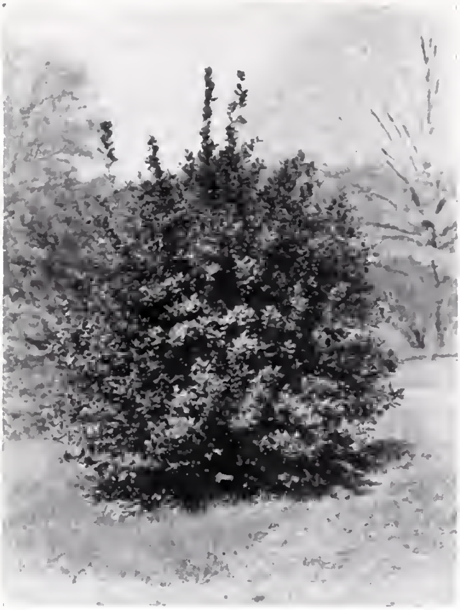
Hollies

Specimen hollies, grown for garden decoration and for berry production, respond well to pruning and actually need it at various stages of their growth. For young plants, initial shaping is essential. This consists in the occasional restriction of side branches, to encourage development of a single straight leading shoot—which often does not form until the fifth or sixth year. In subsequent years subsidiary leaders may require removal, while the heading back of projecting branches will promote a more compact growth. Unless a formal effect is desired, this pruning can be readily done with a pair of hand or long-handled pruning shears; this will avoid a sheared effect. If the holly tree is a good fruiting variety, pruning of this sort can be performed as conveniently at Christmas as at any other time—when the berried branches can be used for decoration. Since this is a purpose for which hollies are frequently grown, it is good to know that a reasonable trimming at Christmas time has never yet harmed a good holly tree.

Other Kinds

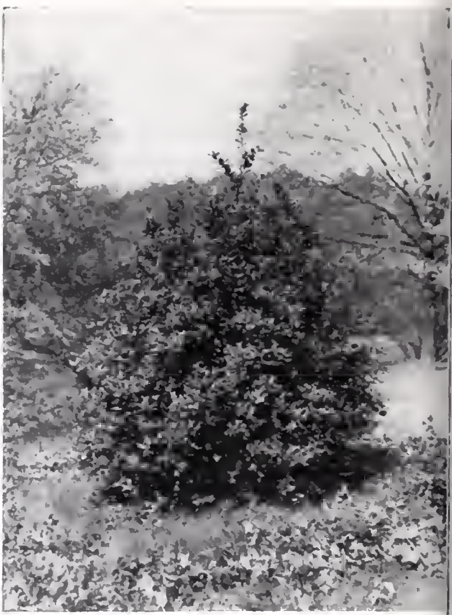
The barberries, cotoncasters, privets, and evergreen firethorns are grown for their flowers and fruits as well as for their foliage and general decorative effect. Such plants as these should be pruned only for shaping purposes in their younger stages or as it becomes necessary to induce compactness or maintain them in scale with their surroundings. Beyond these needs, additional re-

Rhododendron properly pruned so as not to be allowed to become spindling.



Photos author courtesy

Holly (*Ilex cornuta*) in need of pruning.



The same tree shaped by removal of straggling branches and extra leaders.

Firethorn (*Pyracantha*)—not evergreen in the North. Restrictive pruning of young plant to develop a more shapely bush.

striction tends to impair the flower o fruit display since flowers are usuall produced on wood of the previous season.

Shaping of the young plants is ofte necessary, especially with the firethorn (*Pyracantha*). During the first and secon years after planting, the firethorns frequently make almost unbranched leading shoots 4 to 6 feet long. This result in a very ungainly specimen if the situation is not corrected in one of two ways either by 50 per cent removal of eac shoot during the dormant season, or b pinching the longest of these shoots whe growth is half complete, in June.

For the all-round appearance of t evergreen bushes it is usually better, b occasional pruning, to encourage flowe and fruit production on a large numbe of shorter shoots than on a few branche that are too rambling.

Pruning the broad-leaved evergreen is a relatively simple process, once th principles and aims are understood.

PROPER PRUNING OF NARROW-LEAVED EVERGREENS

4 most important part of their maintenance—hey are not untouchable

G. William Longenecker

THE evergreens and other trees and shrubs used in landscape planting ften become overgrown and useless beause of neglect. Proper cultivating, ertilizing, and pruning can do much to nake an initial landscape investment a hing of lasting service and beauty.

Many people know how to water and ultivate shrubs and trees. The use of ertilizer is no longer the complete mysery it once was. Proper pruning, howver, continues to be a difficult problem. t must be so; otherwise we would not ee so many overgrown, poorly pruned andscape plantings.

Many people think that evergreens are ntouchable and should not be pruned, ut this is a great mistake.

The Need

Japanese yews are among the most exensive of the evergreens used for foundation plantings. They usually come from the nursery as well-shaped plants; but if they are left to grow without pruning, in a few years they become ragged, open-branched, and unattractive.

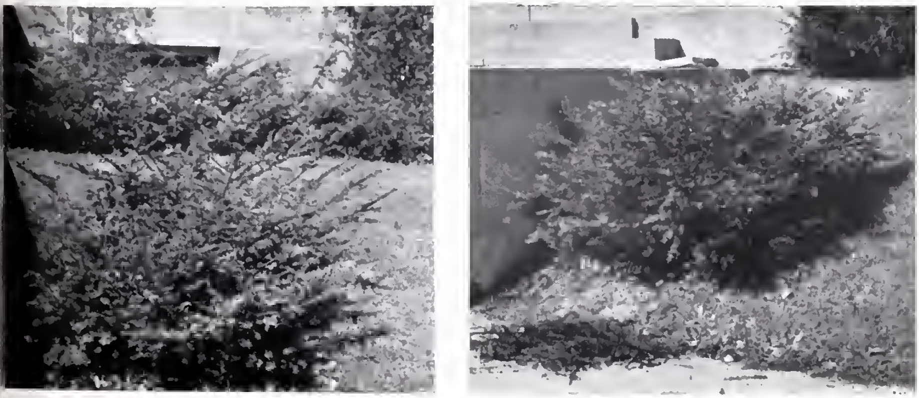
The **Pfitzer juniper** is a vigorous grower; and unless it is properly handled, it may soon become too wide for the space allotted to it at the foundation of a house. It is a common thing for upright junipers and **arbor-vitaes** to become too tall and too open-branched if left to themselves. One does not have to go very far in any neighborhood to see examples of such neglect. Proper pruning can add years of usefulness and beauty to the average planting.

The Method

Small-leaved evergreens such as the arbor-vitaes, yews, and junipers usually should be pruned occasionally when they

Spreading Japanese yew before and after pruning.

Photos courtesy University of Wisconsin



Courtesy University of Wisconsin
American arbor vitae (*Thuja occidentalis*) kept in bounds by shearing.

are grown on the home grounds. These small-leaved types can be safely pruned back at the ends of branches; they form new buds and new growth so easily and at so many places that existing buds may be disregarded. The best time to prune these evergreens is when the new foliage is soft. Pruning back the soft growth and the ends of the branches of the yews tends to thicken the foliage growth and prevent the plant from becoming too tall or too wide, depending on how the cutting is done.

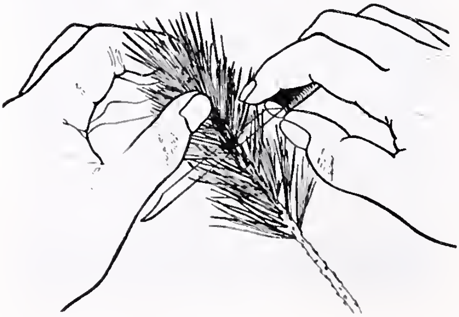
Tall-growing evergreens such as the American arbor-vitae and the red cedar and their varieties may be pruned with a sharp knife in late spring or early summer. Sweeping motions with the blade of the knife up along the edge of the tree can remove the ends of the new growth that extends beyond the normal outline of the tree; this tends to keep the foliage thick. Too frequent pruning of this type may give the tree a sheared, unnatural look which is not in keeping with the average home. Neglect, on the other hand, may necessitate the removal of the tree or pruning so drastic that it will be a long time before the tree is of much value.

Severe pruning or pruning larg branches usually exposes a considerabl amount of old wood, which may be unsightly for some time. Fairly extensiv pruning may be done, however, if th operations are restricted to the region o the green foliage. Cutting off the end of twigs stimulates new side growth o the branches cut and makes the foliag thicker.

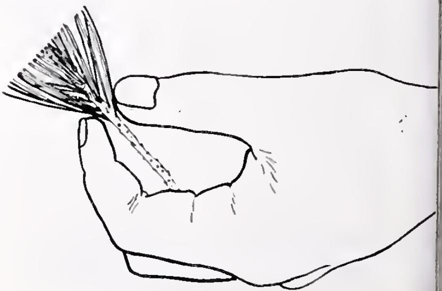
Wide-spreading evergreens such as th Pfitzer and Savin junipers can be kep in bounds if some pruning is done ever year or so. If carefully selected, lon branches can sometimes be removed a the base of the plant. If there is a shorter branch directly above the long on that is cut, the upper branch usuall droops so as to cover the scar and fil the gap.

The **Swiss mountain pine** is in need o frequent pruning if it is to be kept i compact form. The pruning is best don when the new candlelike shoots are full grown but soft. This new growth shoul

Cutting new growth of Swiss mountain pine with knife.



Sheared appearance of cut shoot.



be shortened about two-thirds of the way back to the old growth with sharp pruning shears or knife; or when it is in the crisp state, it can be broken off with the fingers—very easily and quite neatly.

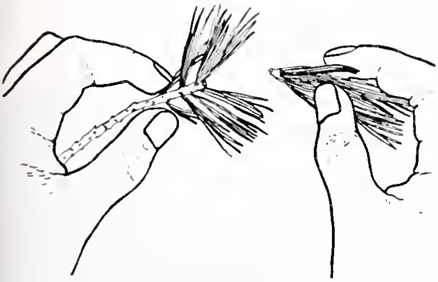
Firs and spruces as a rule need very little pruning; but if trees tend to become too open they can be made to develop more foliage and thicker tops, by proper handling. These trees, however, have to be treated somewhat differently from the small-leaved types. The firs and spruces form side buds along the twigs. Pruning should be done in the late summer or in the fall or winter, when these side buds are present. The cutting should be done in such a way that some of the side buds are left to develop new growth.

Pine, fir, and spruce trees sometimes lose their central leaders as a result of mechanical injury, insects, or some other cause. If a tree thus damaged is left alone, it may become wide-topped and unattractive because a number of buds just back of the injury compete with each other for dominance. If the strongest-growing bud or branch or the one best located is left and the others removed, the tree will soon form a good new top.

A little pruning of evergreens every year or two will prevent the necessity of a major operation at any one time. If evergreens are allowed to grow for several years without care, it may be difficult or impossible to bring them back to the desired size and shape.

McFarland

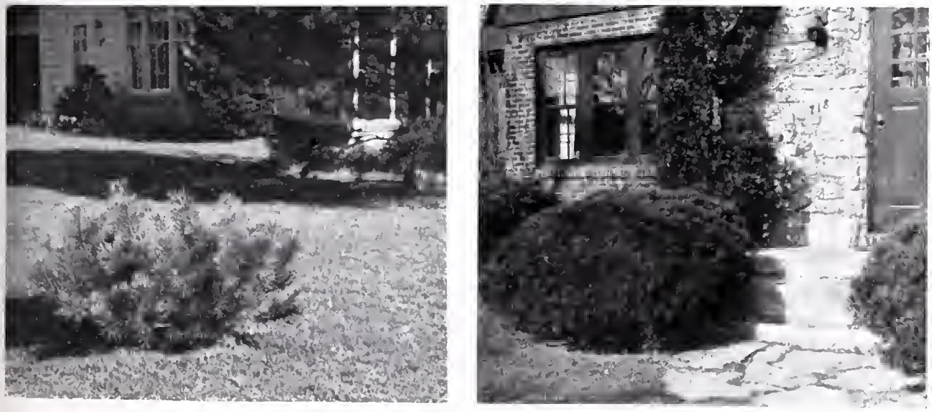
Colorado spruce (*Picea pungens*) with several leaders, all but one of which should be removed.



Breaking new growth of Swiss mountain pine keeps needles intact.

Swiss mountain pine (*Pinus mugo*). *Left:* not pruned, hence open in growth. *Right:* kept compact by pruning.

Photos courtesy University of Wisconsin



EVERGREEN TRIMMINGS IN WINDOW BOXES

Branches that can easily be spared from the trees make attractive arrangements that last all winter

H. B. Tukey

WHEN the colorful flowers of summer are past, the window boxes (which have been an attractive feature) now serve only to emphasize the bareness of approaching winter. Some homeowners prefer to take the window boxes down and store them over winter; but this is a heavy job, especially if the boxes are large.

A happy solution to the problem is to fill the boxes with trimmings of evergreens stuck into the soil. This not only allows the window boxes to be left in place but also adds to the attractiveness of the home.

Time

The best time to do this in northern latitudes is just as the soil begins to freeze but before it is frozen. The first flakes of snow in the air are often a reminder. Just ahead are Thanksgiving and Christmas, associated with evergreens and holiday decorations. One of the pleasant events of the year is to go into the woods (if any are available), or to a nurseryman, or to one's own evergreen trees. A little snow on the ground, a few rabbit tracks, and the whirr of startled birds become a part of the ritual.

Cutting

Branches 2 to 4 feet long should be cut—branches that can be spared or are better removed. It is surprising how much material can be taken from a few trees without harming them in the least. No ugly stubs should be left. A lateral should be severed cleanly where it diverges from a main branch; or the branch may be cut back to the main trunk and any unwanted or barren part may be thrown away.

Material

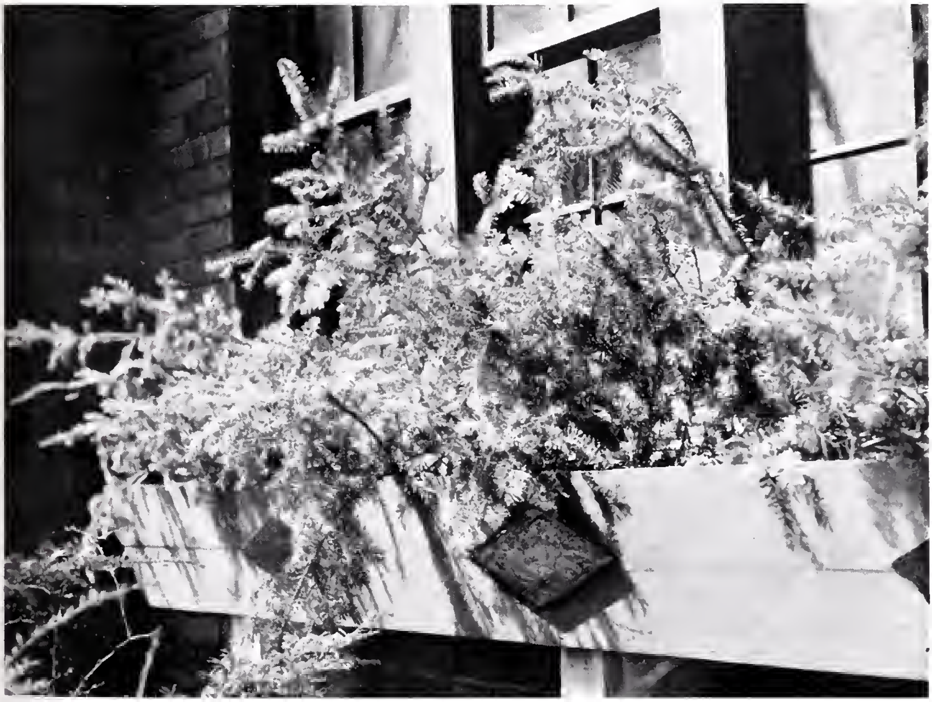
Almost any evergreen material may be used. Norway spruce (*Picea abies*) is easy to procure, but the needles are inclined to drop or to become yellowish. Colorado blue spruce (*Picea pungens*) gives a colorful effect. Balsam fir (*Abies balsamea*) is one of the best materials both for persistence of needles and for retention of good green color. Swiss mountain pine (*Pinus mugo*) is unusually successful, with its stiff vigorous effect and dark green color. Arbor-vitae (*Thuja*) is good, but its branches do not stand erect.

Arrangement

Usually only one kind of material should be placed in a box; the best effect is produced by similarity of texture and color throughout. But if there are several window boxes, one kind of evergreen may be used in one box, and another in another. Branches of various sizes may be used—even pieces as small as 6 to 12 inches long.

The soil in the window box should be well soaked. Then the branches are stuck into the soil, base down, of course. The tallest branches look best at the back and middle of the box, with the smaller pieces filling in the front and ends. A few of the larger shoots may be allowed to sweep outward at the ends (to lengthen the arrangement) or to dip downward in front.

Winter cold freezes the trimmings firmly in place, where they will stay until spring clean-up time demands their removal. Snow adorns them at times, and Christmas tree lights may be strung among them to provide attractive holiday decorations.



Author courtesy

Window box filled with fir trimmings.

SHADE TREE PRUNING

How much should be undertaken by the homeowner and how it should be done

William B. Love

HOMEOWNERS, municipalities, and highway departments are justly concerned with the care and maintenance of shade trees. No phase of tree care offers more for the money from the standpoint of health, appearance, and safety than the properly executed removal of branches for improving the tree. Proper pruning involves the selection and removal of branches detrimental to the tree or to its appearance, in such a manner that injury is minimized and resulting wounds are left in a condition favorable for rapid healing.

Need

Much of the decay present in our older trees has resulted from failure to make pruning cuts that heal properly, or from failure to prune out dead or broken branches. Tight or V-shaped crotches often split or collect moisture and eventually decay. This decay could be prevented by correcting such crotches. The offending branch should be removed before it becomes so large that its removal would ruin the tree.

The prompt removal and burning of dead, dying, or diseased branches has proved helpful in controlling certain insects and wilt diseases. When disease is suspected, pruning tools should be sterilized with denatured alcohol before use on healthy wood.

Large shade trees usually require some pruning, some repairing such as bracing and cabling, and fertilizing every few years. This work should be done by professional tree surgeons who have the equipment and the knowledge necessary to accomplish the work safely. The homeowner should confine his pruning activities to smaller trees or to branches that can be safely reached from the ground or from a short ladder.

Equipment

The bare minimum of equipment required includes a pruning saw with a curved blade that cuts on the back stroke, a pair of strong hand pruning shears, a sharp knife for shaping bark injuries, wound paint, and a small paint

brush. In addition, a pole saw and a pole pruner are convenient for cuts that are hard to reach.

Time

Pruning may be done at any season of the year. However, late winter and early spring are poor seasons for those trees that bleed profusely, such as birches and maples. The best season for pruning is in the early summer after the trees are in full leaf; at this season growth is most rapid, and so the *callus* forms most readily around the edges of pruning wounds.

Method

All final cuts must be made flush with and parallel to the parent branch or the main leader of the tree. Stubs not only are unsightly but will not heal over, and so they make a ready access point for decay and insects to enter the tree.

Large cuts should be avoided, if possible; but where they are necessary, precautions should be taken to prevent stripping down of the bark. When a large branch must be removed, an undercut should first be made, a foot or two from the trunk, until the saw starts to bind or pinch. A second cut should then be made from the upper side of the branch, at a distance equal to the radius of the branch beyond the undercut. The branch should drop off cleanly, and no person or object should be in such a position as to be injured when it falls. The stub should then be removed flush to the main stem. Care must be taken not to strip the bark down: the stub may be supported during the cutting; or a small undercut may be made just beyond where the final cut will come through.

The last step is to cover the exposed wound immediately with a suitable wound dressing: either an asphalt-base tree paint or shellac. Wounds should be repainted at intervals of six months to a year until they are completely healed over. The wound dressing helps to prevent rapid drying and checking of the wood, and to keep out wood-rotting fungi and boring insects.

Newly Transplanted Trees

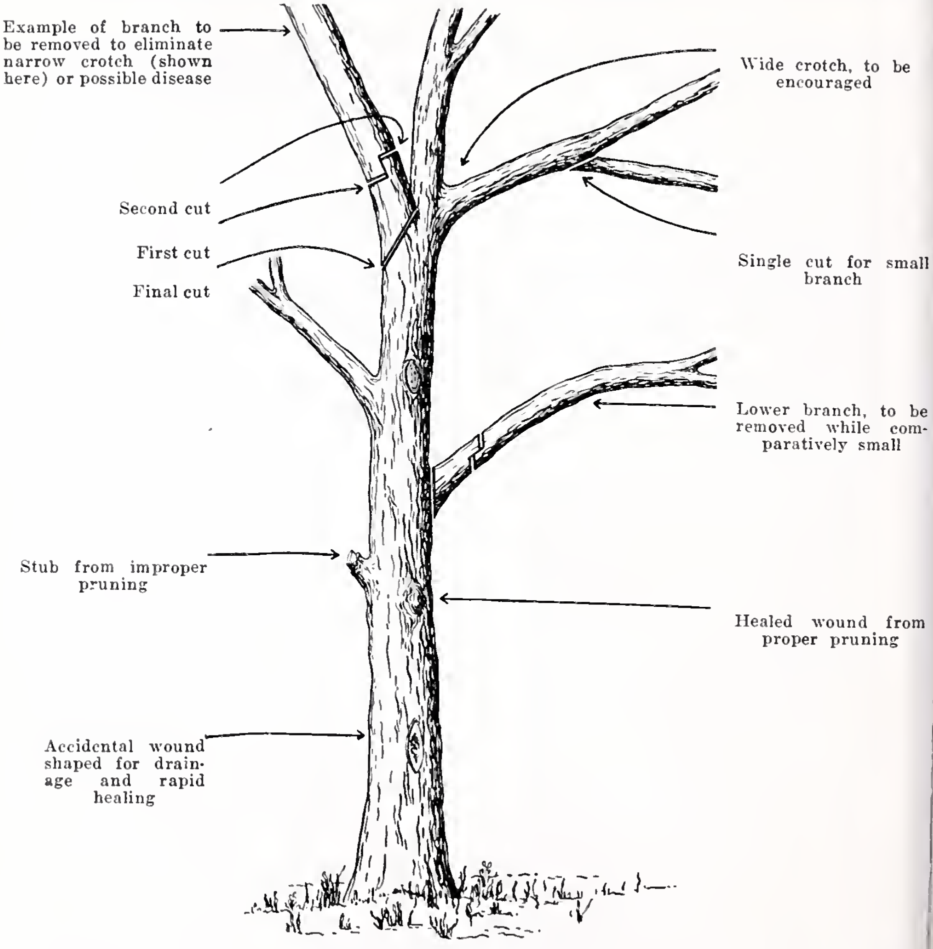
Our first concern is the newly transplanted tree. The tree should be planted where it will have plenty of room for growth and development. For information on pruning at the time of transplanting, see page 147 of this issue. Some of the lower branches may be removed at the time of transplanting; but this is not too important at this time; it may be desirable only to shorten them and to remove them for head clearance after the tree is established.

Lower branches should be removed for overhead clearance before they become over an inch or two in diameter, to avoid large wounds which will not heal satisfactorily. As the tree grows, it should be inspected periodically. Broken, crowded, or rubbing branches should be removed; branches forming good open crotches should be encouraged, while those forming tight V-crotches should be removed to forestall future trouble. It is seldom desirable to top or head back trees except as a safety measure or as a means of rejuvenating old trees that are dying in the tops.

Accidental Wounds

Bark wounds such as may be caused by the bumper of a car or by children trying out a new hatchet often lead to severe decay unless promptly treated. Such wounds should be trimmed with a sharp knife; they should be made V-shape at top and bottom, and smoothed along the edges; all loose bark within the wound area should be removed. The edge of the freshly cut bark should be covered immediately with shellac to prevent the delicate living tissue from dying; then the whole exposed surface should be protected with a good wound dressing.

Pruning applied correctly is our best insurance that trees will develop properly and remain healthy and free from decay and breakage.


Example of branch to be removed to eliminate narrow crotch (shown here) or possible disease
Second cut
First cut
Final cut
Stub from improper pruning
Accidental wound shaped for drainage and rapid healing
Wide crotch, to be encouraged
Single cut for small branch
Lower branch, to be removed while comparatively small
Healed wound from proper pruning

How to trim a shade tree.

Author courtesy

ROOT AND TOP PRUNING IN TRANSPLANTING

For shade and ornamental trees up to 4 inches in diameter—directions for the homeowner

William B. Love

Root Pruning

IT is desirable to prepare wild trees or shrubs for transplanting by root pruning a year or two ahead of the actual moving. Such a practice encourages the development of fibrous roots close to the trunk and minimizes shock and root loss at the time of moving. Root pruning should be done early in the spring.

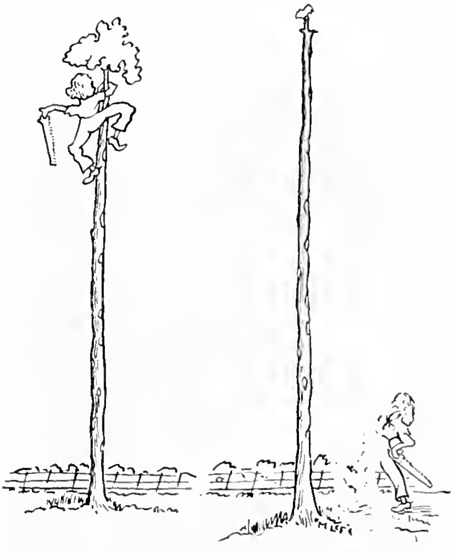
Root pruning of small trees and shrubs may be accomplished by severing the lateral roots with a sharp spade in a circle around the stem. The circle should have a diameter of 10 to 12 inches for each inch of diameter of the stem.

For larger trees it is necessary to dig a trench around the tree, using the same rule for the diameter of the circle. The trench should extend to the depth of the lateral root system. Any roots encountered should be cleanly severed with a sharp instrument. After the trench is dug, it should be filled with topsoil, which may be enriched with peat moss, compost, or well-rotted manure. During dry weather the ball and trench should be well watered weekly to assure adequate moisture for root growth.*

Digging Deciduous Trees

Deciduous trees may be moved either bare-rooted or with a soil ball adhering to the roots. Trees suffer less shock when moved with a soil ball; but most small deciduous trees up to 3 inches in diameter are moved bare-rooted. Tying up low branches with soft rope or strips of burlap facilitates handling.

Bare Root. A trench is dug around the tree to the depth of the greater part of the root system. Roots encountered should be cut with a sharp instrument. Around trees that have not been previously root pruned, this trench should be dug at a radial distance of 5 to 6 inches from the trunk for each inch of trunk diameter. If the trees have been root pruned, the trench should be dug just outside the root pruning area.



Pruning can be overdone.

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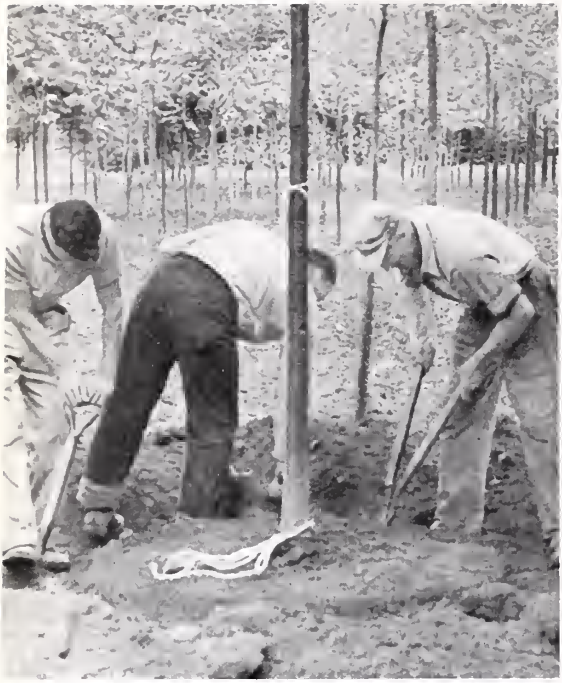
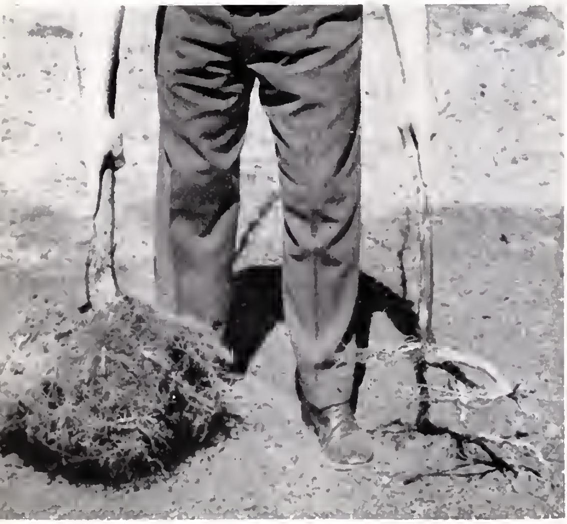
*See further note on page 151.—Ed.


Courtesy Rosedale Nursery

Trenching around a tree and cutting roots (root pruning) preliminary to transplanting.

Young dogwood trees moved in from the wild. *Left*, root pruned two years previously. *Right*, not root pruned; this tree died before the end of the first season.



The roots are then combed: a fork is inserted into the face of the earth ball, and the handle pulled toward the operator. All the roots should be cleared of soil except those within a foot or so of the trunk. As the roots are uncovered, they should be wrapped in wet burlap to prevent drying and injury. When most of the roots are uncovered and wrapped, the tree can be tipped over to raise the roots; the entire root system should then be wrapped with wet burlap and tied with rope. When the trees are to be transported in an open truck, it is advisable to cover them with a canvas to prevent excessive drying.

Soil Ball. Whenever possible, deciduous trees with a stem diameter over 3 inches should be moved with a soil ball adhering to the roots. The moving of large trees is a job for experts equipped with specialized tree-moving equipment since the soil ball often weighs severa tons. The average homeowner should no attempt to move trees over 3 or 4 inches in diameter; but if the equipment and man power are available, larger trees may be moved.

The desirable size and shape of th ball depend upon the rooting habits o the tree, the main objective being to enclose the greatest possible number o roots in the smallest possible soil mass The soil ball should be 9 to 12 inches i diameter for each inch of diameter o the trunk. A trench is dug through th lateral root system at a slightly greate diameter than the anticipated ball, s that the ball can be trimmed into shap Exposed roots should be cut flush wit the outer surface of the ball. The botto of the ball should be tapered in so that will be 6 to 12 inches smaller than the to

The ball should be wrapped with burlap or canvas. A long strip of stron burlap is preferable but gunny sacks ma be slit and overlapped to cover the to and sides of the ball. When the burla is in place it should be tightened an pinned togethed with nails so that it fi snugly.

The ball should then be laced wit

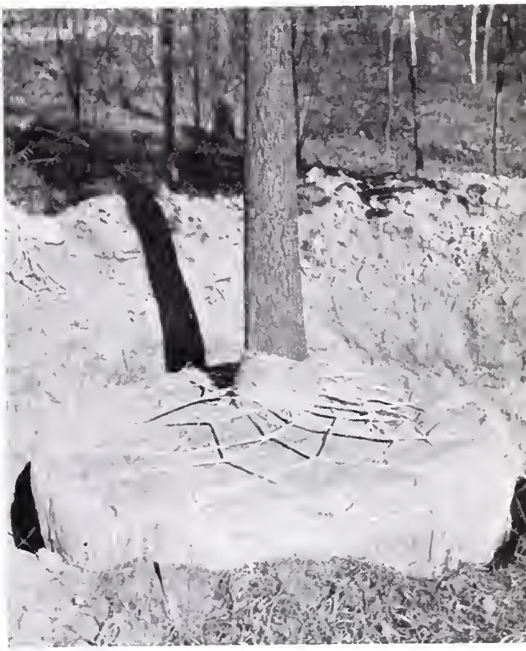
ropes. First, a rope is tied around the bottom of the ball just above the lower edge of the burlap. A second rope is tied in a circle on top of the ball about 6 inches in from the perimeter of the ball. It should be pinned in place temporarily with large staples. Another rope is then tied to the top rope and laced back and forth loosely through the top and bottom ropes at 10- to 15-inch intervals. After the lacing is in place it should be tightened, and the top should then be laced across.

For trees that are too large to be lifted by hand, one side of the hole should be enlarged and sloped to permit skidding the ball out. The tree may be tipped over to break the ball loose or a winch cable can be used to cut under the ball. Care must be taken to prevent breaking the ball during digging or moving operations. The ball can be slid out on a platform of two layers of boards nailed crosswise. A winch or block and tackle can be connected to a rope sling placed around the ball to skid it to the platform. Or the tree can be tipped over and the platform slid under the ball; then the platform can be pulled out of the hole on rollers and planks.

To get the tree on a sled or truck, heavy planking can be used as a skidway, or the ground can be dug away to lower the conveyance so that the ball can be skidded directly to it. The tree is then lowered, supported, and lashed securely in place, with plenty of padding to prevent injury to the bark.

Digging Evergreens

Evergreens are always more safely moved with a soil ball. The method of digging is similar to that described for deciduous trees; but evergreens usually have a more compact root system and can safely be moved with a slightly smaller ball. For small evergreens, burlap may be placed under and around the ball, pinned in place with nails, and tied tightly in place with twine or light rope. Larger evergreens should be balled and laced as described for large deciduous trees.



Tree to be removed from nursery; soil ball covered with burlap and laced with ropes.

Photos courtesy Rosedale Nursery

Bottom of soil ball broken loose and ready to be covered with burlap before tree is lifted out.

Top Pruning

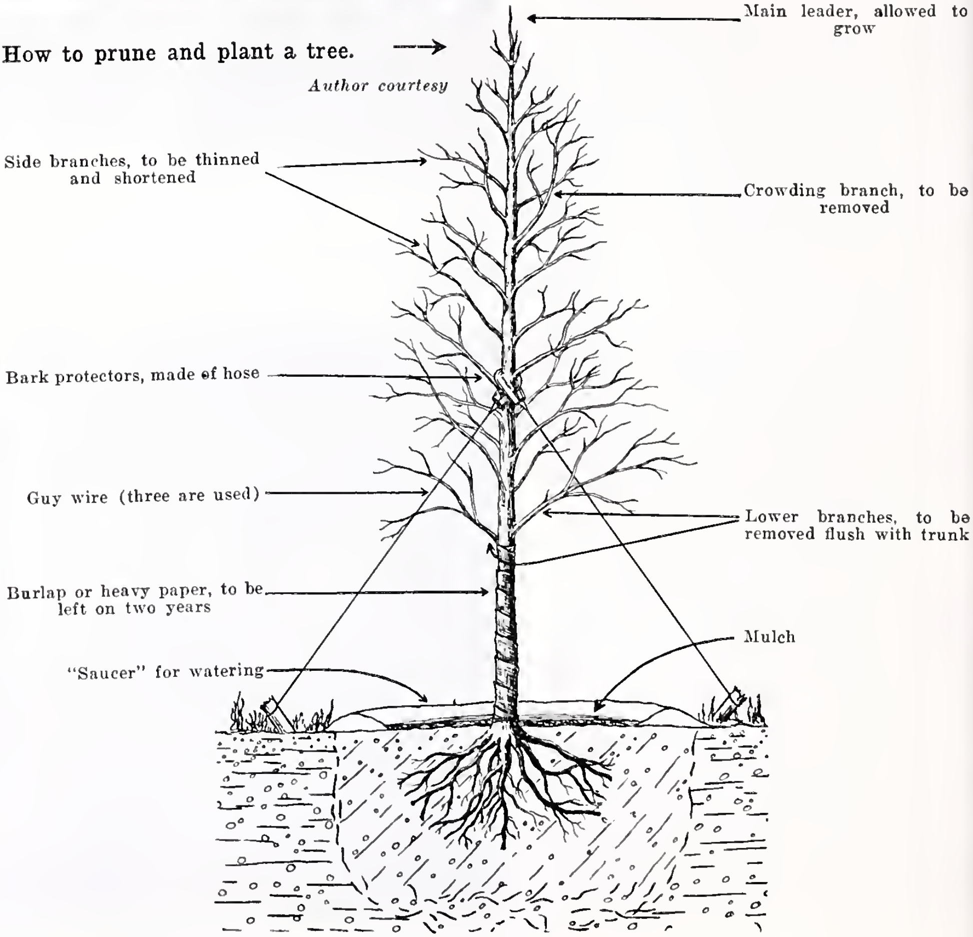
A deciduous tree or shrub requires pruning when it is transplanted, to bring the top into conformity with the reduced root system so that there is not an excessive loss of water through the leaves. Nursery-grown stock usually does not need to be pruned so heavily as wild stock since nursery care tends to develop better root systems. The equivalent of one third to three fourths of the buds should be removed at the time of trans-

Large tree, balled and burlapped, being removed from hole.

Photos courtesy Rosedale Nursery

How to prune and plant a tree. →

Author courtesy


Main leader, allowed to grow
Side branches, to be thinned and shortened
Crowding branch, to be removed
Bark protectors, made of hose
Guy wire (three are used)
Lower branches, to be removed flush with trunk
Burlap or heavy paper, to be left on two years
Mulch
"Saucer" for watering

planting. The amount of pruning required depends on the extent of roots lost and the condition of those remaining. Balled stock does not usually require pruning so severely as stock that is moved bare-rooted. Pruning should be confined to secondary branches, so that the main leader is intact and the form of the tree is not damaged. Side branches should be cut back one third to one half their length, to a good lateral branch. Branches unnecessary to the form of the tree should be removed flush with the trunk; tight or weak crotches should be removed, and all crowded or rubbing branches; and if there are two leaders, the weaker one should be removed. Small twigs near the trunk and near the top of the tree should be left; they are essential for circulation and will shade the trunk from direct sunlight.

Tree removed from hole and ready for truck.

Evergreens generally do not require pruning because they have a compact root system and because they are usually balled before moving. The pruning of evergreens should be delayed until just before growth starts in the spring; at that time damaged branches may be removed and very light pruning may be done, if necessary, to improve their shape.

FURTHER NOTE ON ROOT PRUNING FOR TRANSPLANTING

For large trees it may be best to extend the trenching over a two-year period. The circular trench should be measured and staked out and divided into six equal portions. Every other section should be dug the first year, and the alternate ones the second year. The removed earth may be thrown back, but it is always beneficial to add some organic matter and a small amount of a complete fertilizer.

F. L. O'Rourke

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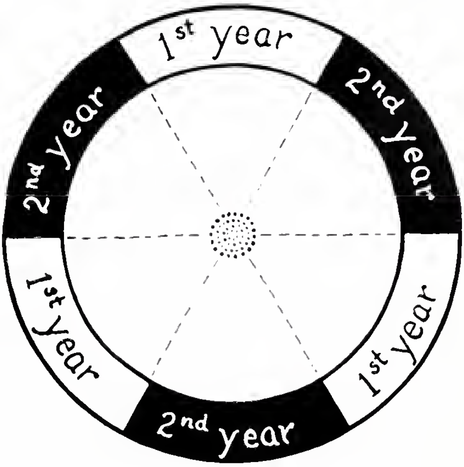


Guide for two-year root pruning for transplanting a large tree.

ROOT PRUNING

For dwarfing fruit trees and keeping them fruitful, for keeping evergreens within bounds, and for conditioning trees for transplanting

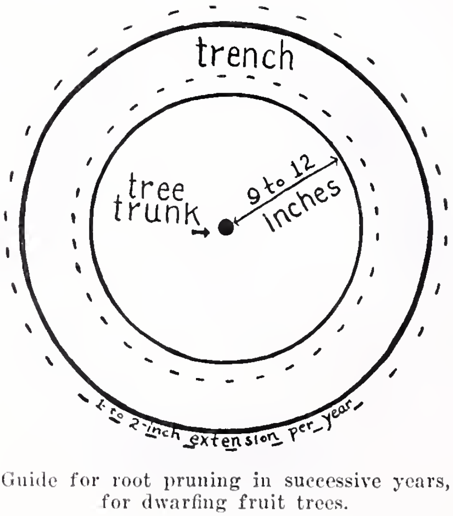
F. L. O'Rourke

ONE hundred and seven years ago the pioneer American pomologist A. J. Downing quoted the equally eminent and even earlier English horticulturist Thomas Rivers, in regard to certain advantageous responses of fruit trees to root pruning. According to a pamphlet published by Rivers in 1843, pruning the roots rendered the trees smaller in size (and thus permitted easier thinning and picking), induced earlier fruiting, permitted adjusting the soil conditions, and conditioned the tree for easy and quick transplanting.

Fruit Trees

In the earlier part of the nineteenth century the labor incident to trenching, cutting the roots, and refilling the trench with good fertile soil and compost was not the expensive item that it is to-day. In England at that time root pruning was apparently a common practice. That was the age of complex and highly evolved types of training such as the espalier, cordon, and quenouille forms. Root pruning was almost a necessity for keeping the trees within bounds. The practice favored the formation of short shoots with blossom buds rather than lush vegetative growth.

In our modern fruit gardens we now use a dwarfing type of root stock* to keep the trees small and compact, and root pruning is not so important as formerly. Root pruning is still a good practice, however, irrespective of root stock, particularly if done every year or at least at frequent intervals.



Guide for root pruning in successive years, for dwarfing fruit trees.

Method

The approved method is to dig a circular trench at least 18 inches in depth at a suitable distance from the trunk, according to the size and vigor of the tree. Ordinarily one should allow a radius of 9 to 12 inches for each inch of trunk diameter. In succeeding years the circle may gradually be extended by 1 to 2 inches for each pruning. The roots should be cleanly cut, either with the spade or with shears. Bruised roots are subject to infection and do not heal well. When the trench is complete, the larger roots may be severed with slanting blows of the spade or with lopping shears. Fertile soil high in organic matter should be placed in the trench, and the whole area covered with a light mulch.

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*See Plants & Gardens, Autumn, 1951, page 176.—Ed.

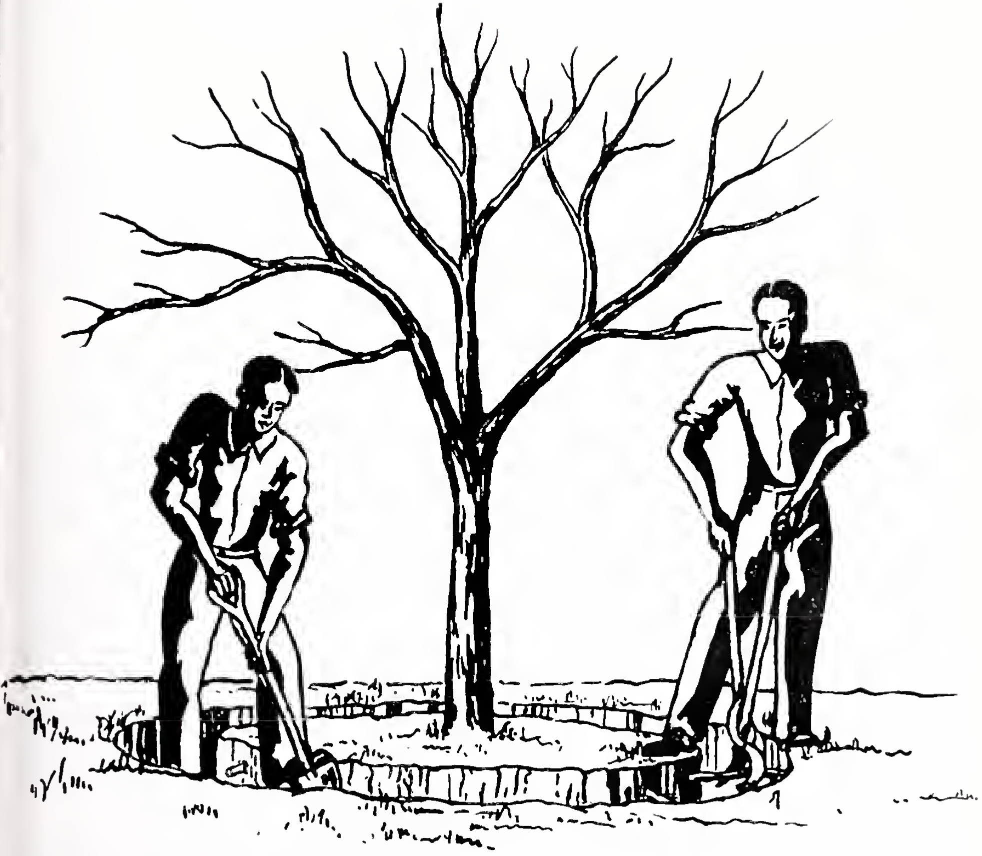
Late fall is considered the best time for trenching, as the soil is still warm and moisture is at an optimum to promote healing and rapid root growth. A transverse cut through a root stimulates the formation of new roots, which grow at right angles to the main root and then gradually penetrate the mass of soil in the filled trench. The following year the trench diameter may be widened by about 2 inches and the same process repeated. If this trenching is done year after year, the tree will grow slowly but remain in a fruitful condition.

Evergreens

Root pruning is also commonly practiced to keep evergreens small and shapely. In some instances the roots are cut by merely plunging a long-bladed sharpened spade into the earth rather than by trenching. It is usually best to work in a little complete fertilizer at this time; otherwise the restricted root zone may not contain enough nutrients to keep the trees in good condition.

Transplanting

Another use of root pruning is to condition a tree for transplanting. For details of the method, see pages 147 and 151 of this issue.



Cutting the larger roots in root pruning.

TOMATOES AND CUCUMBERS GROWN ON THE GARDEN FENCE

Increased yield of superior fruits in a limited area by proper spacing, pruning, and training

James H. Burdett

TOMATOES and cucumbers may be grown in the small home garden, each in no more space than it takes for a row of beans, if they are allowed to climb.

Tomatoes

Spacing. The heaviest tomato yield and the earliest fruit, for space occupied, will be given by a row of plants set 12 inches apart and pruned to a single stem. Plants set 21 inches apart and pruned to two stems give almost as many fruits.

Pruning is easy to do but requires watchfulness. The plant starts with a central stem or leader. At each joint made by a leaf with the stem, a branch begins to grow. In pruning, these side shoots are removed before they are 4 inches long.

If two stems are to be allowed, one side shoot is left to grow, starting not more than 10 inches from the ground. Pruning must be done weekly.

No leaves should be pruned from the main stems of tomato plants. The fruits need the leaves to make food for their growth; they also need the shade furnished by the leaves, to avoid sunburn. The so-called **determinate** varieties should not be pruned or staked. The first blossoms can be made to set fruit by being sprayed with a hormone sold for that purpose.*

Staking. A single-stemmed plant may be twisted around a cord stretched from a 5- or 6-foot support of any kind to an anchor on the ground near the plant. A two-stemmed plant should be tied to its support by loops of soft cord or cloth which will not cut the stems.

Watering and Mulching. Tomato roots spread widely just below the soil surface, and cultivation should never be so deep as to disturb them. An abundant supply of water is required; and lack of it causes decayed spots on the fruit opposite the stem, a condition called blossom-end rot. Moisture can be conserved by a mulch of lawn clippings, 6 inches thick, all along the tomato row.

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*See PLANTS & GARDENS, Spring, 1952, page 18.—ED.

Cucumbers

All **cucumbers** will climb; no one should be induced to choose an inferior variety on the plea that it is a climber. The usual sorts should be planted in a row, 6 to 10 inches apart, and should be provided with a support which they can ascend as soon as the vines develop. Seed should not be sown until warm weather is established, usually about May 20. Plant food, a pound to 25 feet of row, should be spread in a trench 2 inches away from the seed.

Melons will climb too, but the weight of the fruits is often too great unless they are supported by mesh bags tied to the fence or trellis.

The support for all these plants should be not a solid wall or tight fence; rather single stakes or a picket fence, which will allow air to circulate freely through the growth.

Courtesy National Garden Institute

Pruning a side shoot of a tomato plant.

PRUNING BRAMBLE FRUITS

How and when to cut and train the various types of blackberries and raspberries, to obtain vigorous growth and abundant yield

A. S. Colby

Growth and Fruiting Habits

BEFORE pruning can be correctly done, the growth and fruiting habits of the plant must be understood. During the growing season each year all brambles send up new shoots from the crown, and some (erect blackberries and red raspberries) send up shoots from both crown and roots. These shoots grow vigorously if unchecked, and during the late summer and early fall begin the formation of flower buds. If headed back early in the growing season, shoots of black and purple raspberries and erect blackberries usually develop strong side branches, along which lateral buds form.

Early in their second season these 1-year-old shoots (called canes after the first year) produce leafy shoots from lateral buds. A few compound leaves appear first, and then both single blossoms and clusters of blossoms, followed by the fruit. After fruiting, the cane gradually dries up and dies. The roots live for several years, sending up new shoots which replace the canes that have fruited and died. Everbearing red raspberries bear fruit twice on the same cane, in the fall at the tip and again the next spring farther down.

Pruning Tools

There are three types of cutting tools to use for pruning: the small pruning shears*; the long-handled, or lopping, shears*; and the bramble hook. Usually either the long-handled shears or the

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*Illustrated on pages 115 and 117.—Ed.

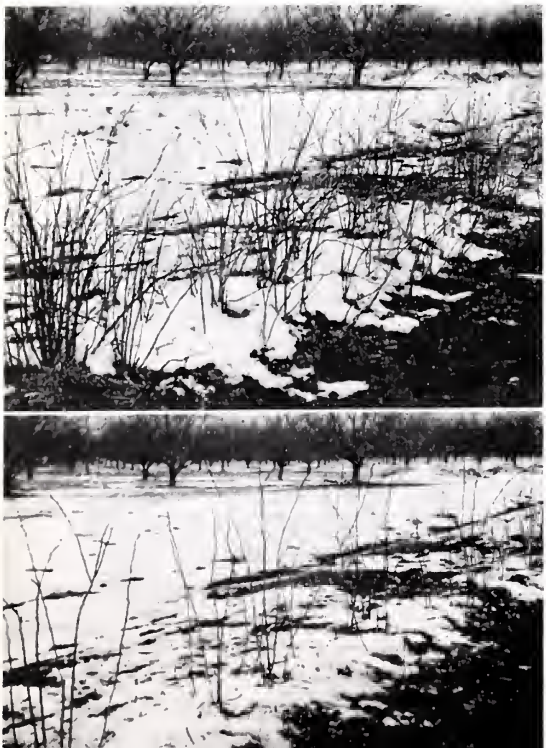
Photos courtesy Illinois Agr. Exp. Station

Summer-topping young shoots of purple raspberry, to induce growth of strong lateral branches for the following year's fruiting.

hook is used in cutting out and removing the dead wood and surplus canes, and the small shears for cutting back the laterals. Care must be taken not to pull out the whole plant when the bramble hook is used.

All tools should be kept sharp and free from rust.

Young red raspberries, before and after dormant pruning.



Summer Pruning of Young Plants

The amount of pruning needed by young plants depends on their growth. Having been cut back rather severely at planting time, they may not be sufficiently established the first growing season to require additional pruning. If, however, they have got a good start and have grown rapidly, they need some training.

Black Raspberries. When the young shoots have grown about 18 inches high, about 2 or 3 inches of the top should be pinched off with the thumb and forefinger. This operation, known as "topping" the plant, is illustrated in the photograph. Shoots thus handled tend to become stocky canes with vigorous lateral branches. It is necessary to go over the patch at least twice, usually in May, to top the shoots at the proper height.

Purple Raspberries and Erect Blackberries. These are of more vigorous growth than blackcaps and should be allowed to grow a few inches taller before being topped.

Red Raspberries should not, as a rule, be topped. The new laterals that result are generally weak, often break away from the cane when fruiting the following year, and are easily winterkilled. Topping red raspberries tends to induce more sucker plants than are desirable.

Dormant Pruning

Red Raspberries. The dormant pruning of red raspberries should be done before growth starts on the young canes in early spring.

The dead canes that have fruited should be removed first. Some growers prefer to remove and burn old canes in the fall after the fruit is picked and the leaves on the bearing canes are beginning to turn yellow. If the canes are removed in the fall, special care should be taken not to injure the young succulent shoots. In the hill system these young shoots may be tied loosely to the stakes as a convenience in later cultivation, in spraying, and in sowing a cover crop.

Short and weak canes should be removed in late winter or very early spring after severe weather is over. Only large, vigorous, healthy canes should be left and these should be spaced 4 to 8 inches apart, as shown in the photograph.

The remaining fruiting canes should be cut back moderately. The exact amount of cutting that is desirable depends upon the variety, the soil type, and the method of training. The object is to remove winter-injured wood, which usually occurs *at the tip.* On everbearers this tip will have borne fruit the previous fall. Severe heading back should be avoided in pruning red raspberries, as it materially reduces the number of berries without producing a corresponding increase in their size.

Canes may be left 4 to 6 feet tall, according to local conditions. If left too long to be easily supported by either the stakes or the wires used in training, they become top-heavy with fruit; the crop suffers from being blown about, and if blown to the ground becomes dirty and unfit for use. If grown in hills, the canes should be tied firmly to the stakes immediately after pruning.

Blackcaps and Purples. *Old canes* should be removed before growth starts in the spring—preferably (for combatting some insects and diseases) soon after the fruiting season is over. In dormant pruning, any remaining dead canes should be removed, and all *diseased and spindling* ones; and the hills should be thinned out by removal of *all the canes that are not at least half an inch in diameter.* Every effort should have been made to induce the growth of very large canes. All large canes in good condition may be left, since the plant can support, for fruit production, as many as it has grown.

Any dead fruiting laterals or branches should then be *cut away,* and *those remaining* should be *headed back,* the severity of heading depending upon soil moisture and fertility. From eight to twelve buds may usually be left on each branch, and the branches left about 6 to 8 inches long, as shown in the photograph. On the purples, which are more vigorous than the blackcaps, a larger number of buds may be left, with laterals up to 14 inches long, as illustrated here.

Photos courtesy Illinois Agr. Exp. Station

Purple raspberry before and after dormant pruning.

The laterals of blackcaps and purples *may be cut back severely without* materially reducing the total yield. Though the total number of berries is reduced, the size of the individual berries is usually so much increased that the yield is about the same as when the laterals are left longer. Short pruning reduces the length of the picking season and minimizes the effects of drought.

Erect Blackberries. *The dead canes* that remain, and the *weak and crowding 1-year wood* should be removed before

Black raspberry after dormant pruning—pruned more severely than purple varieties.

growth starts. Vigorous well-branched canes should be left—about 8 inches apart if the plants are growing in moist, fertile soil, or as much as a foot apart if soil conditions are not so good. If the rows are narrowed down to less than 2 feet in width it is not usually necessary to use a support, as the branched canes support themselves.

Blackberry varieties differ somewhat in their fruiting habits, owing to differences in the position of the fruit buds along the lateral branches; but the varieties grown most commonly in Illinois produce good crops if the laterals are cut back to about 12 inches. Longer branches may be left if the plants are so located that soil moisture and protection from sun and wind are ideal at the time the fruit matures.

Summer Pruning and Training in Mature Patch

Raspberries and Erect Blackberries. When plants reach full bearing, the late-spring or early-summer tipping back, or *topping,* of the young shoots becomes of increased importance. Topping (as shown on page 156) encourages the formation of strong lateral branches.

Blackcaps should be topped in May or early June in the well-established patch, when the shoots have reached a height of about 2 feet. About 3 inches of the tip growth, with the young leaves, should be removed.

Purple raspberries and erect blackberries, because of greater vigor, may be allowed to grow 2½ to 3 feet high before being topped. Shoots that grow after the topping season usually develop into weak canes and should be cut out when dormant pruning is done.

Red raspberries are not summer-topped

Semi-erect and Trailing Blackberries From experimental work at the Illinoi Station there is no reason to assume tha summer pruning of these brambles i profitable or practical. Shoots of Boysen, Logan, Young, and Lucretia ma be trained along the row on the ground Shoots of varieties such as Brainerd ma be tied up.

After the crop is picked the old fruiting canes should be removed. Becaus of the difficulty of cutting away the ol wood from several of these varieties without injuring the young shoots, som growers in southern Illinois find it mor satisfactory to cut out both old and ne wood from these varieties at this time When the young shoots are cut away i this manner, it may be advisable to appl fertilizer in order to induce a quick ne growth.

In early spring the strongest cane should be lifted from their horizonta position. The Brainerd is so vigorou however, that many of its young shoot will have already established themselve in a semi-erect position on the trellis. I stakes are used for support, the cane should be wound around the stakes, tie at two or three places, and cut to abou the height of the support. On a hor zontal trellis having wires attached t cross-arms, the canes are wound aroun the wires and tied at intervals. On vert cal trellises having the wires one abov the other, the canes are tied to the wire without being wound around them.

HOW TO PRUNE CURRANTS AND GOOSEBERRIES

The best fruit is produced on wood 1 to 3 years old. Yield is increased by annual removal of older canes and thinning of newest ones

A. S. Colby

CURRANTS and gooseberries are usually trained to the bush form rather than to the tree form; hence they are commonly called bush fruits. They should be made to grow upright with an open center, and any horizontal limbs low enough to be on the ground should be removed. The plants usually bear their fruit just at the base of the previous season's growth or on short spurs on older wood. These spurlike growths are comparatively short-lived. The best fruit is borne on young wood not over 3 years old. Black currants bear the most and best fruit on wood of the previous season's growth. Gooseberries bear fruit on year-old wood and on spurs from older wood.

When to Prune

Bush fruits need little pruning until they are about 4 years old. After that time they need attention. Warm, pleasant days in winter offer the best time for doing the work, which should be done annually.

Currants

In pruning currants, if the bushes have been regularly cared for, it is necessary first to cut away the oldest, least productive canes and then the surplus 1-year-old canes, leaving about six to eight of these yearling growths well distributed over the bush. (These canes may be easily recognized; they are gray in color and are usually straight, with no lateral branches.) Wood from 1 to 3 years old is then left; this will bear as much fruit as the plant can mature properly. A small amount of 4-year-old wood may be left on especially vigorous plants.

If the plants have been neglected for several years, little yearling wood is found. The bush is filled with old dead canes. The annual growth at the end of the canes is weak, and the fruit will be poor in quality and small in size. In such a case, the oldest wood should be removed, to open the bushes to the light and air. If the bushes are well fertilized and sprayed, they will be rejuvenated and new fruiting wood will come from regular annual growth of new shoots; then good crops may be secured.

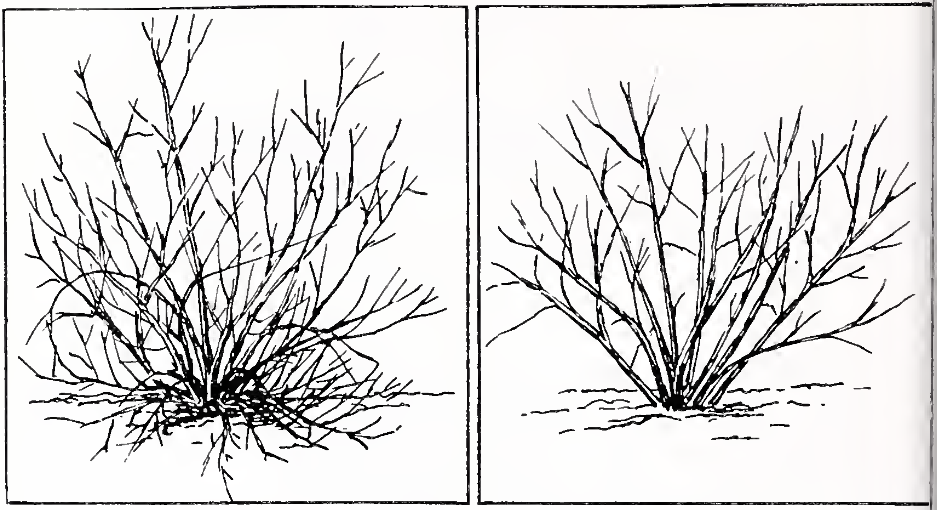
White currants are pruned like the red varieties. Black currants are allowed more yearling canes to the bush, and the older wood is removed earlier.

Gooseberries

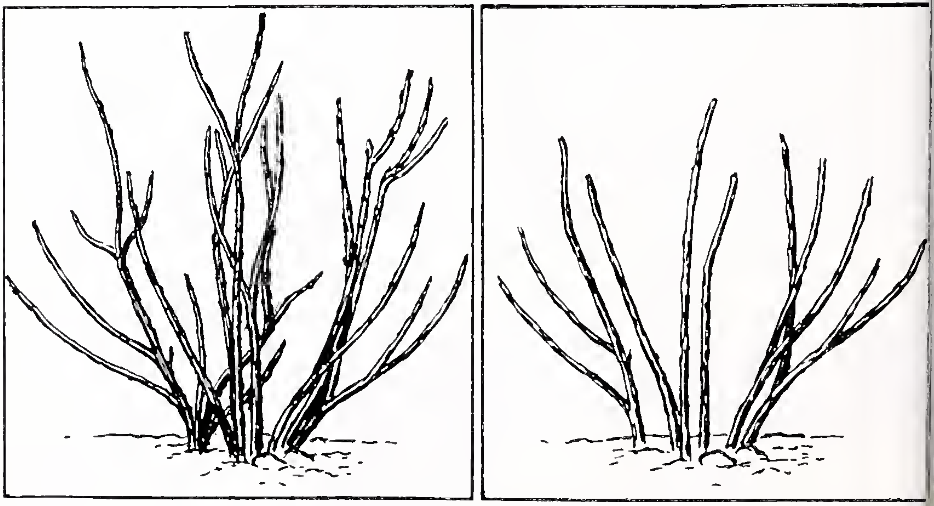
Gooseberries are more vigorous than most currants, tending to branch laterally on shoots of the same season. This habit of growth makes for a compact bush. More wood must therefore be cut away from gooseberries to keep them open. Few gooseberry plants are pruned severely enough.

It is rarely necessary to head back either shoots or canes, but more attention should be given to the removal of surplus wood.

Note: Currants and gooseberries should not be grown within 1000 feet of white pines, because they harbor one stage of a serious disease of the pines (blister rust) —Ed.



Gooseberry bush before and after pruning.



Currant bush before and after pruning.

Redrawn from American Fruit Grow

SOME PRINCIPLES OF PRUNING

A few basic facts about the growth of trees, and their application to the practice of pruning—with special reference to fruit trees

H. B. Tukey

Compiled from the writings of E. J. Kraus

THE subject of pruning is so broad and there are so many phases of it, that in brief discussion it is possible to touch upon only a few of the more important aspects.

Three general principles are helpful.

Uneven Cutting

Of closely competing branches, the one cut the most grows the least. If two branches of about equal size are coming out close together, and one of them is cut off shorter than the other, the longer one will produce more growth during the following season. This growth is not always manifested as new shoots; it may show in greater diameter or in the forming of spurs along its length, especially if the tree as a whole is not very vigorous. The effect of such long and short pruning accumulates from year to year and furnishes an ideal method of preventing weak Y-crotches which are certain to result when even cutting is practiced.

Favoring the Strongest Shoot

Usually, the shoot from the bud nearest the point of cutting tends to outgrow those from the buds below it. If the cut is very close to a bud, or if the pruning is done early in the season so that drying occurs, the second bud generally makes the most growth. Also, the shoot arising from the uppermost bud most closely follows the same direction of growth as the terminal portion of the shoot removed.

Considering this fact in connection with the first principle, if we desire to suppress a terminal branch more than the shoot below it, the cutting back of the terminal one must be much heavier than if we desired to allow it to follow its natural tendency and outgrow the one below it.

These two principles indicate why even cutting results in Y-crotches. In even cutting, the tendency of the terminal branch to outgrow the one below it is offset by the fact that it is necessarily pruned shorter than the one below it if the tips of the two are at equal height after the heading back has been done. The result is that the two grow equally and nothing other than an equal fork is possible.

Heading Back vs. Thinning Out

When the yearly growths of most varieties are headed back, there is a strong tendency toward more profuse branching than when no heading is done. This is especially true of young, vigorous trees. It is virtually another way of saying that heading back thickens the top and usually results in a denser tree and more vegetative growth. The headed-back tree is likely to be sturdier, the thinned-out tree slenderer and more willowy.

Overpruning (either heading back or thinning out) has a decided tendency toward dwarfing the tree and delaying fruit production; in most instances trees that are lightly pruned come into bearing at an earlier age than those more severely cut.

WEDGE PRUNING OF FRUIT TREES

A new style of pruning that improves fruit production and facilitates spraying, thinning, and harvesting

H. A. Cardinell

FRUIT trees of bearing age are invariably too tall and too dense for convenient management. Part of their fruit is usually small in size, poor in color, and infested with insects and diseases. Conventional styles of pruning are often unsatisfactory because the effect is of short duration. An aid in overcoming this difficulty is a comparatively new style of pruning, called **wedge pruning.** It is gaining in popularity because it facilitates selection of the best branches, makes other operations easier uch as fruit thinning, harvesting, and aying) and allows sunshine to reach re fruit and potential fruit buds.

Beginning the first wedge zone in a 13-year old apple tree.

Photos courtesy Michigan Agr. Exp. Statio

Making the Wedges

Wedging, or clover-leaf-style pruning, ives a tree resembling a four-leaf clo- r. With a sharp pruning saw, lopping ears, and ladder, as illustrated and scribed in the Autumn, 1951 issue of LANTS & GARDENS (page 210), the perator removes enough limbs and ranches to form a V-shaped opening. hree to five such openings are pruned ut, in accordance with the size of the ree. Each wedgelike opening should be 4 to 6 feet wide at the periphery and should extend to the trunk, or center of the tree area. It should also extend t the top. The wedge-shaped openings nee not be spaced equally unless it is desirable to reduce crowding between tre rows. Usually it is possible and advisable to place the "doors," or openings where the fewest large scaffold limb must be sacrificed. The first two illustra tions show the operator removing mostl branches 1 to 2 inches in diameter, i making the first wedge. With matur trees, from 300 to 500 pounds of brus will be removed to produce four wedge zones. Ordinarily the removal of thin wood (to get rid of weak shoots near the center of the tree) along with surplus sucker wood is all that is necessary.

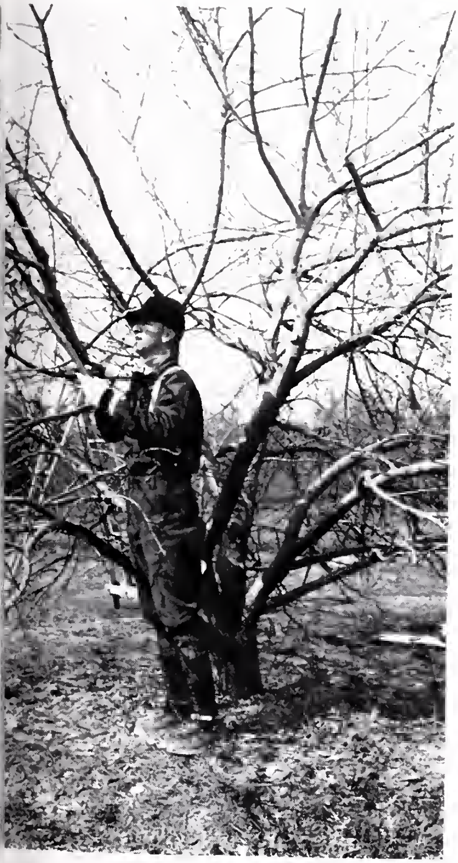
Advantages

This method of pruning offers a good opportunity to get rid of many crowding, weak, or troublesome main limbs. Every tree owner has walked away from a tree with a guilty feeling, lacking nerve enough to remove fine large limbs, knowing full well they should never have been allowed to grow. The tree has won again, and so the decision is again put off until another year. The tail has wagged the dog. One who adopts wedge-style management ruthlessly searches out those areas needing correction, for he must cut his way into each zone. A glance at the illustration of the finished wedge-pruned tree should convince anyone of the advantages of having convenient openings where workers may enter, shoot in spray or dust, place ladders, and harvest well-colored fruit.

This is truly a pruning method for the convenience and satisfaction of the owner of fruit trees.

Subsequent pruning is merely a matter of keeping the wedge zones open, removing weak, thin wood and cutting back tall branches that are out of reach of sprayer and picker.

First wedge zone finished.



Same tree as shown at left, with its crop of 616 pounds of apples.

THIN-WOOD PRUNING OF FRUIT TREES

How to recognize and remove slender unproductive branches to make trees produce more high-quality fruit

H. P. Gaston

THE *thin-wood* method of pruning is based on the following related facts concerning the growth habits of trees.

All of the fruit-producing wood found in trees of bearing age can be classified as either thick, intermediate, or thin.

The three types of wood have distinguishing characteristics that make them easily recognizable.

Considerable differences exist in the productive capacities of the three classes of branches.

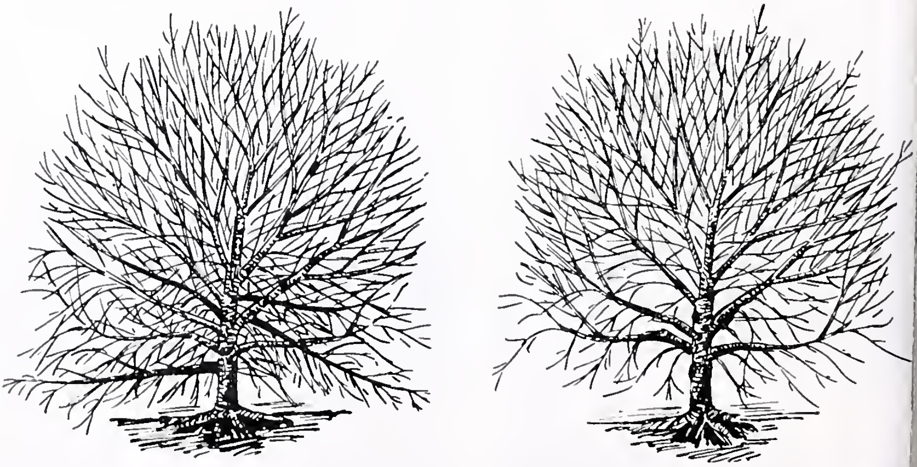
Thick wood tends to bear heavily; and the fruits are of superior size, good color, and high quality.

Intermediate wood tends to bear moderately; and the fruits are of moderat size, color, and grade.

Thin wood is not very productive; an the fruits are of small size, poor color and inferior quality.

Reduced to its simplest terms, thin wood pruning consists in removing fro the tree the slender, relatively unproductive branches. The four outstandin characteristics of thin wood are:

- Relatively small diameter.
- Short terminal growth.
- Tendency to grow in a downward direction.
- Location mostly in the lower, inne part of the tree.



Drawings courtesy of the auth

Tree before and after first step in thin-wood pruning.

Thin-wood pruning eliminates many f the small, poorly colored fruits that ould otherwise be produced. It also enbles the tree to bear more fruit of large ize, good color, and high quality.

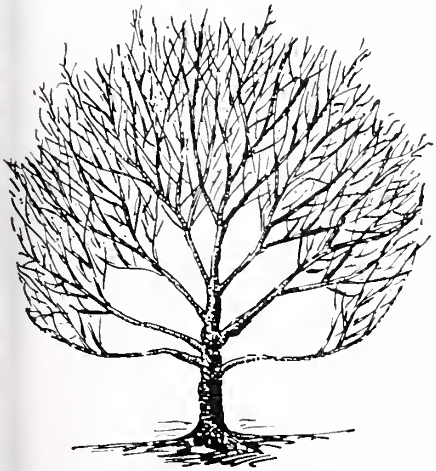
First Step

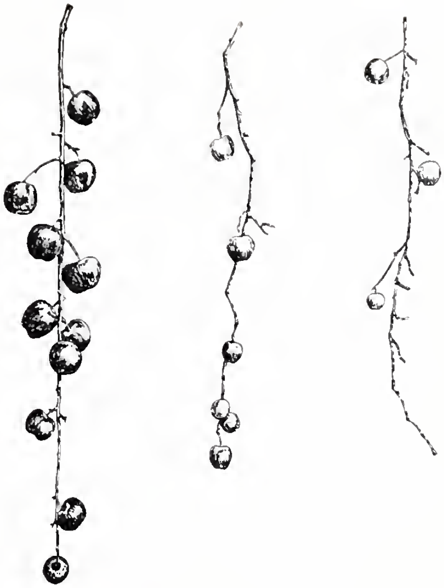
In almost every bearing tree that has ot been previously pruned by the thinood method, there are several comparaively large limbs that give rise to a umber of smaller branches virtually all f which are of the thin-wood type. Such imbs usually grow in a horizontal or ven downward direction. The weight of crop is likely to pull their extremities o the ground, where the fruit is almost ure to be damaged.

The first step in thin-wood pruning is o remove large branches of the sort just described. This is done with a saw. he first branch to be cut is taken at the ost convenient point; then the worker roceeds around the tree, making all the ecessary cuts of this type. The removal f these larger branches makes the subequent work easier.

Second Step

After having made the saw cuts just escribed, most pruners prefer to do the remaining work with loppers or hand shears. With one of these tools the worker moves once more around the trunk of the tree, this time removing the thin wood that remains in its lower and inner part. The accompanying sketches show the tree before and after the lopping or shear work has been done.


ree after second step in thin-wood pruning.


Branches of thick, intermediate, and thin wood with the number and size of fruits they are likely to bear.

Final Step

Most of the cutting is done in what is here described as the first and second steps. In the case of younger trees it remains only for the worker to stand on the lower branches of the tree and remove any thin wood that could not be reached from the ground. In older and larger trees, some climbing or the use of a short ladder may be necessary. In any case, when the thin wood has been removed from the inner part of the tree the job is finished.

A general article on pruning fruit trees appeared in Plants & Gardens, Autumn, 1951, page 210.—Ed.

SUMMER PRUNING

For increased bearing in young fruit trees—if not overdone

H. B. Tukey

Compiled from the writings of E. J. Kraus

Method

ABOUT the middle of June or July, depending on the locality, the new wood of the branches of the season begins to toughen from the base toward the tip. When the hardening has progressed to a suitable length to leave the branches (the same length as in winter pruning), and the leaves on the part to be kept are as far apart as they would be in the fall, the softer upper portion is clipped off. From the more vigorous upright branches sometimes a foot or more is cut; from the less vigorous laterals it may be necessary to remove only 4 to 6 inches. Competing branches should be cut unevenly in summer pruning, the same as in winter pruning. See page 161 of this issue. It is unnecessary to cut the smaller, weaker branches at all.

Within a few weeks new branches will start in the angles of the upper leaves below the cut. Varieties behave differently, but ordinarily two to four good sprouts may be expected. These new or secondary branches usually grow from 3 to 18 inches long by fall. Thus, instea of a long, unbranched shoot as a resul of the season's growth, there is a sturd basal part, 12 to 18 inches long, fro which arise two to several less sturd shoots ranging from mere spurs t branches of considerable length.

When winter comes, if too many o these secondary branches have been produced, it is well to thin them out moderately; and if the growth has been exceptionally long, it is well to tip the back lightly. Most of these branches require no winter pruning whatsoever, an this is just where the system gains ove continued winter heading-in: during th coming season these branches behave a do ordinary nonheaded ones, and the are the ones that tend to become fruitfu

Effect

This has been tried for a number o years; the young trees have been observed to bear earlier and at the sam time to maintain good form. The sam type of summer pruning may be conti ued a second or third season if the trees continue to grow vigorously; in some cases this almost eliminates the need of winter pruning. It is preferable not to use this type of pruning on trees before their second growing season, and not then unless they are vigorously vegetative.

Discussion

The old saying of pruning in the summer for fruit and in the winter for vegetation is of very doubtful value as a basis for practice. Summer pruning often produces as many water sprouts and undesirable limbs as does winter pruning; and heavy pruning of older bearing trees in summer may prove disadvantageous.

The many phases of summer pruning cannot be considered in detail here—but one word of caution against overdoing such pruning: summer pruning can be seriously devitalizing; and merely devitalizing a tree by no means insures that it will be more fruitful. As a matter of fact, actually to devitalize a tree lessens its value instead of increasing it, no matter what the means of devitalization. It is true that fruit production is often an accompaniment of decreased vegetativeness, but such decreased vegetativeness does not necessarily indicate devitalization. Trees that have been seriously suppressed vegetatively are often more fruitful when they are rejuvenated or again stimulated into greater vegetative activity.

FAN-STYLE PRUNING

For filler trees in orchards—whether these are used to supplement the yield while the permanent trees are growing, or to provide for cross-pollination

H. A. Cardinell

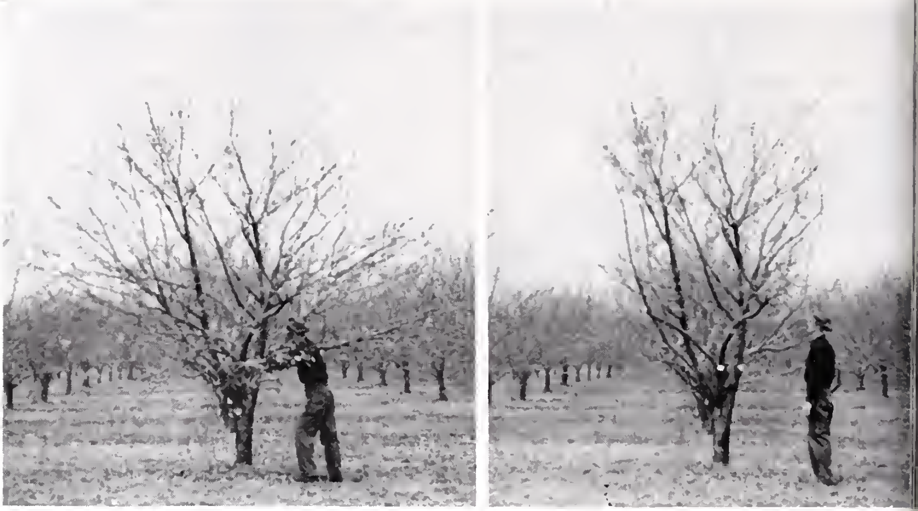
TWO trees in an urban planting may be too crowded for the welfare of either. Crowding exists also in the majority of commercial orchards. At the time the trees are planted, spacing peaches 40 to 60 feet apart, for example, seems to be an unnecessary waste of ground; therefore, most people cut the distance in half. The use of dwarfing stock to produce smaller trees was expected to solve this problem, but it seems not to have done so. Most semidwarf trees are planted 10 to 12 feet apart; within five to seven years such plantings are too close.

For Early High Yield

There is sound economic reason for commercial orchardists to plant more trees per acre so as to obtain the earliest possible heavy yield. To make this possible, *filler rows* are often planted between the rows that are intended to be permanent. It seems to be against human nature to destroy good trees; the result is that most plantings retain all the filler trees. It is practical to *fan-prune* or *hedge-row* the trees in the filler rows.

Fan-style pruning is best done by degrees. The contour of the land usually determines the direction of cultivating, mowing, and spraying. According to the need, one or both sides of temporary trees may be sheared off so that equipment may easily pass and so that the permanent trees will not be hampered by shading and by root competition.

After trees are once sheared off on two sides, it may be necessary only to cut off or cut back limbs as the weight of crops



Courtesy Michigan Agr. Exp. Stat

Apple orchard with filler rows. Tree in foreground, before and after fan-style pruning.

bends them down so that they interfere with adjacent trees or hinder use of equipment.

It is economical to reduce the size of the trees in the temporary rows and add their production to that of the permanent rows. Observation and experience have shown that the heavy removal of side limbs (in pruning trees to the shape of a fan) results in the production of high-quality fruit. By the time the permanent trees are again crowding and touching the branches of the temporary rows, and by the time temporary trees must be cut back on two or more sides (and eventually on top) to such an extent that their production is reduced to 1 to 3 bushels of fruit per tree, the filler trees should be removed. By this time there will be little loss in yield for the acreage and the most sentimental owner will have enough nerve to remove such unsightly dwarfed specimens — unless they are needed for cross-pollination.

For Cross-pollination

Many owners plant self-unfruitful varieties, which require capable cross-pollinating varieties close by. Many of our best varieties seldom produce hea yields without cross-pollination; a even with self-fruitful varieties cross-pollination is said to improve size a coloration of fruit. Thus, many owne are trapped by the necessity of providi for cross-pollination of the favored v-rieties.

There are three ways of meeting t s need:

1. Grafting or budding branches f crossing varieties in the tops of enou of the favored trees.
2. Providing crossing bouquets duri g the blossoming period.
3. Planting trees of crossing variet s in *filler rows* between the rows of the p-ferred variety.

Having enough filler trees is often e best permanent solution to a pollinati g problem. In such cases fillers may be f-pruned or dwarfed in any manner. T e essential thing is to preserve one or m e top limbs to serve as attractive bouqu s for bees and wild pollen-carrying inse s.

This is the one case in which fil r trees should be permanently maintain ; and fan pruning is an excellent way o keep them useful and prevent crowdi .

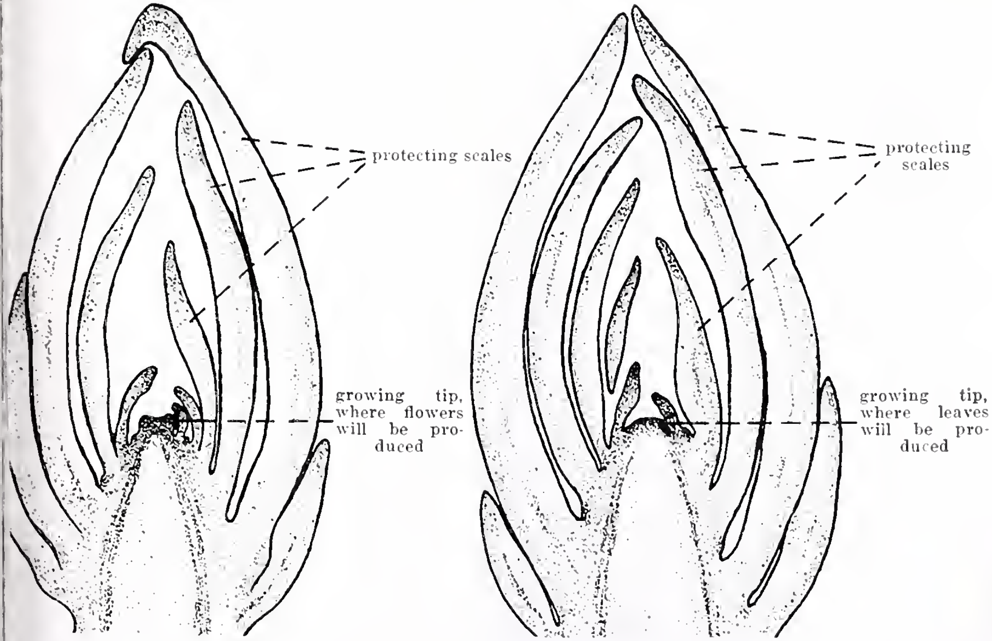
HE PRODUCTION OF FLOWER BUDS 3Y TREES AND SHRUBS

Vhen and on what part of the plant flower buds are formed on ifferent kinds of woody plants, and the bearing of these facts on commended methods of pruning

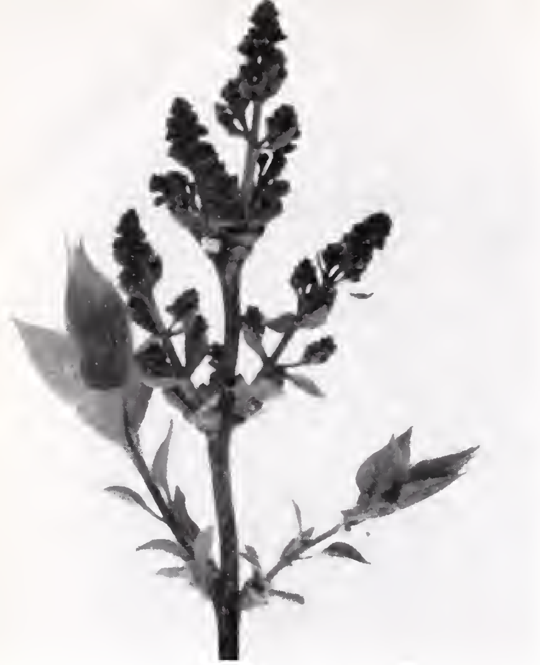
E. J. Rasmussen

Time of Formation

N general, blossom buds on deciduous trees and shrubs are formed during e summer previous to bloom. The time blossom bud differentiation varies ith the kind of tree or shrub, the va- ety, the season, and the locality. This riod of differentiation ranges from rly July to the first part of September. A two-year study on apple trees in New Hampshire showed that the period of blossom bud *initiation* was of relatively short duration (about two weeks) and that more blossom buds were initiated during July and August in dry weather than when rainfall was abundant. No doubt weather conditions during the period of blossom bud differentiation also influence the amount of bloom on ornamental trees and shrubs.


protecting scales
growing tip, where flowers will be produced
protecting scales
growing tip, where leaves will be produced

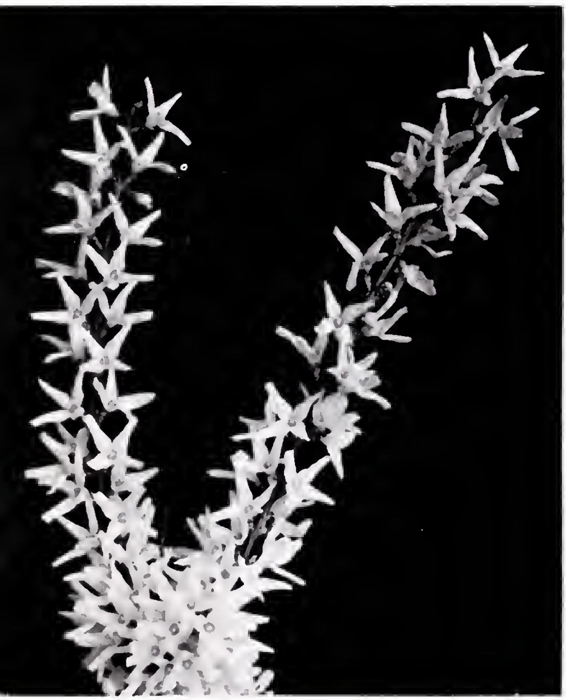
ple buds in early August, cut in two lengthwise (diagrams magnified). *Left,* flower bud. *Right,* leaf bud.



Author courtesy

Lilac branch with clusters of flower buds at tip, and leafy branches below.

Forsythia branch with flowers all along the sides of the stems.



Recognition

Blossom buds can easily be distinguished from leaf buds at a fairly earl stage. A bud may be cut in two lengthwise through the middle and examine with a small 10-power magnifying glas A single-edged razor blade makes a goo knife for cutting the buds.

In any bud, either young leaves o young flower parts can be seen developing near the tip of the short cone-shape stem. In a leaf bud the tip of the ste appears semicircular in the sliced bu In a flower bud (cut lengthwise) the ti of the stem looks as if it had been raise narrowed, and flattened. The parts of th flower (sepals, petals, stamens, and pistils) can all be recognized within six t seven weeks after flower bud initiatio takes place.

Position, in Different Plants

Trees and shrubs vary in the age wood on which flowers are produced ar in the position of flower buds in relati to the leaves on twigs and spurs. Shru and trees that produce blossoms on lea shoots or twigs require a different met od of pruning from those producing blo soms on spurs, as is illustrated by pea and apple below. On a shrub that pr duces its bloom in many axillary bu along the stems (forsythia, for exampl it is necessary to maintain a differe type of wood from that on a shr blooming mostly near the tips of t stems—such as lilac.

Examples

The position of flower buds and t type of wood on which they are produc in a few common ornamental and fr plants are shown in the accompanyi pictures.

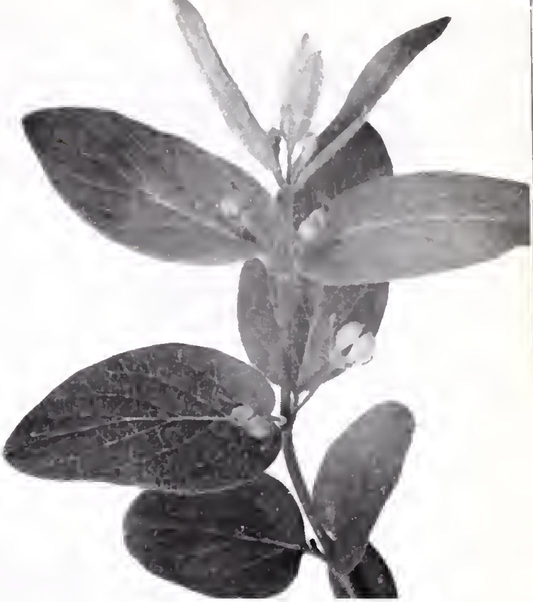
Lilac. Blossoms are usually produc in the pair of buds at the tip of t previous season's growth. On vigoro shoots blossoms may be formed in t upper two pairs of buds. Because of th habit of blooming, the upperm branches fail to continue growth a new shoots must develop from side bu ower on the twig in order to produce loom in succeeding years. This growth f side shoots explains the bushy growth abit of lilacs.

For continued heavy blooming, the aded flowers should be trimmed off be-ore they go to seed. They may be napped off at the base of the stalk; or here several clusters have developed, he branch should be cut back to the first ud that did not produce flowers. This s also a good time to cut out old and eak stems and stems that may be ubbing against each other.

Forsythia (as well as several forms of pirea) produces flowers from axillary uds along the stems of the previous ear's growth. Old wood should be cut ack to the ground as soon as flowering finished in the spring. The new growth r the year often amounts to as much as feet. Late in the season (about a onth before frost) the tips should be t back about 25 per cent. This forces ort side branches which will produce ower buds for the following spring.

Honeysuckle. The bloom develops in e axils of leaves on the shoots of the me season. Therefore, any pruning ould be done before the plant begins grow in the spring.

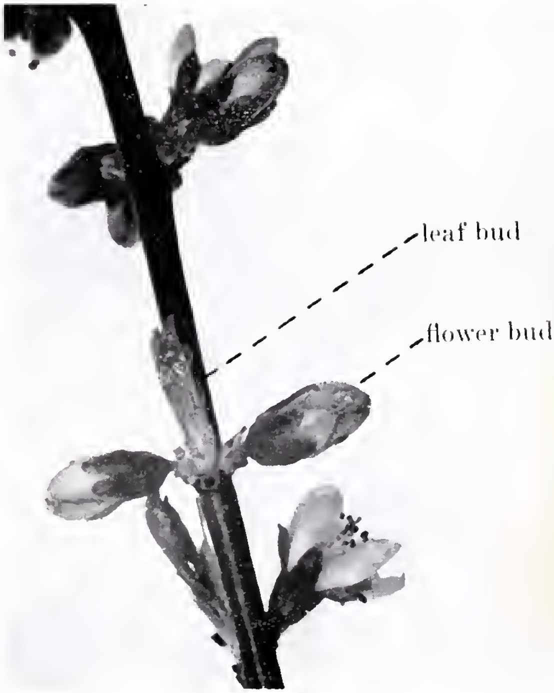
A good general rule for pruning shrubs is as follows: If the shrub blooms in the spring, it blooms on wood produced the year before, and so it should be trimmed as soon after blooming as possible. This permits a maximum amount of time for growth of new wood for bloom the following year. If the plant blooms in the summer or fall, it blooms on new wood formed the same year. Pruning should be done in late fall, winter, or early spring before new growth starts, so as to force as much new growth as possible before the blooming season.



Honeysuckle flower buds in axils of leaves (angles between leaves and stem).

Photos author courtesy

Peach flowers, borne singly on each side of a leaf bud.



Blueberry flower bud clusters near end of branch.

Plum flowers on sides of older branch and spurs; leaves at tips of spurs.

Photos author courtesy

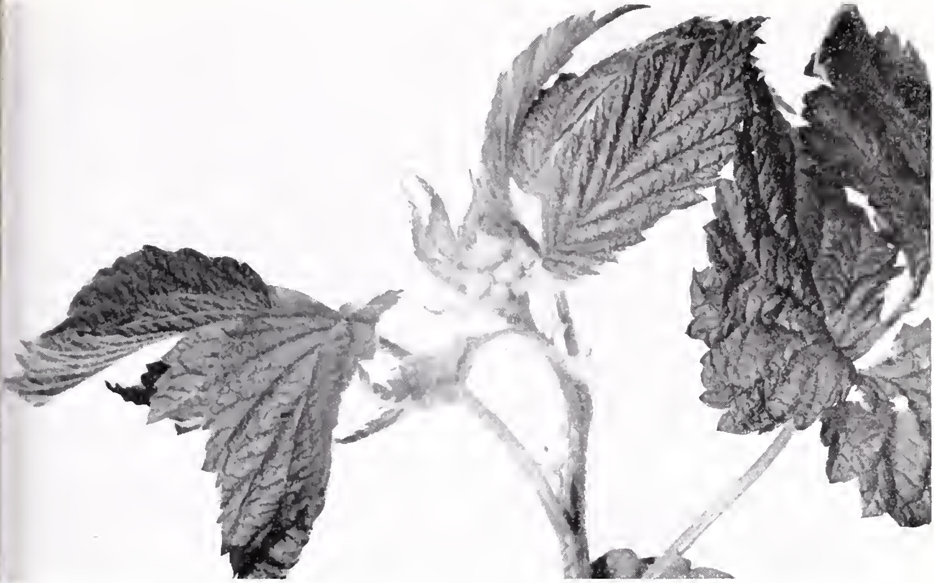
Peach blossoms are formed on shoot of the previous year's growth, and ar borne singly on each side of a leaf bud After peach trees reach bearing ag (about two years after purchase fro the nursery) reasonably heavy pruning i usually necessary every year in order t stimulate growth of new shoots for fruiting, and also to help prevent overloading with fruit.

Plum and **Cherry** blossoms are produced in axillary buds on older branche and on short slow-growing branches, o *spurs.* These axillary buds may contai one to three or more blossoms. The terminal buds on twigs and spurs are usuall leaf buds. Therefore, in successive yea the twig and spur continue to grow their tips and should not be trimmed of especially if axillary flower buds are ev dent. Actually, cherries and plums r quire little trimming, once establishe The elimination of duplicating and dea branches or the heading back of branch that make the tree look unbalanced usually all that is necessary.

Apple blossom buds are usually bor at the tips of the short side branches, *spurs,* on wood at least 2 years old older. Leaves also grow on the spur, a buds in their axils develop into ne spurs in succeeding years.

Since apple trees are vigorous growe some trimming should be done each ye during late fall, winter, or early spri before growth starts. The "whisker must not be cleaned off the branches, f they already are or will develop in fruiting spurs. Growth of these sh lateral spur branches should be encou aged, and long branches discourag The branches should be kept tipped ba and those that duplicate each other rub against each other should be eli nated. Branches at the center should trimmed out to keep the center of tree more or less open to the sun.

Blueberry blossoms are formed clusters in several of the upper buds shoots produced the previous year. T number of buds producing flower clust depends upon the vigor of the sho



Raspberry flower buds at tip of branch and in axils of upper leaves.

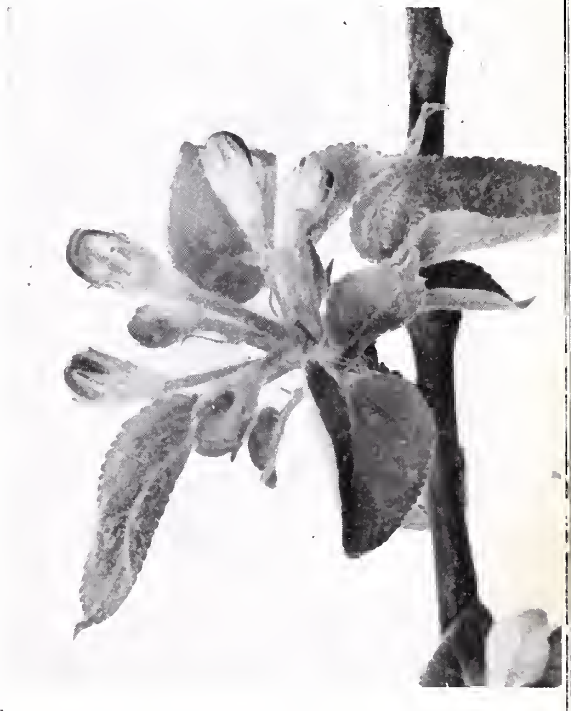
This type of bloom requires frequent renewal of stem growth. Lowbush blueberry fields are burned over every two or three years; this maintains good wood and keeps the plants productive. In the home patch, the older bearing wood of the highbush blueberry should be removed from time to time to encourage growth of new branches.

Raspberry produces flowers in terminal buds and in buds in axils of leaves on branches developing the same season. These shoots develop from buds on branches (or *canes*) produced the previous year. A raspberry cane lives but two years. Therefore, each fall or winter all canes that produced berries the previous season should be cut down to the ground, except in everbearing varieties; on these the fruiting canes should be tipped back but not removed.

A knowledge of how plants grow, the time of blossom bud initiation, the age and vigor of wood that produces the best bloom, and the arrangement of flowers and leaves on twigs and shoots, is all-important in understanding the recommended cultural practices and is also an aid to greater enjoyment of one's garden.

Photos author courtesy

Apple blossom buds at tip of spur; leaves on sides of spur.

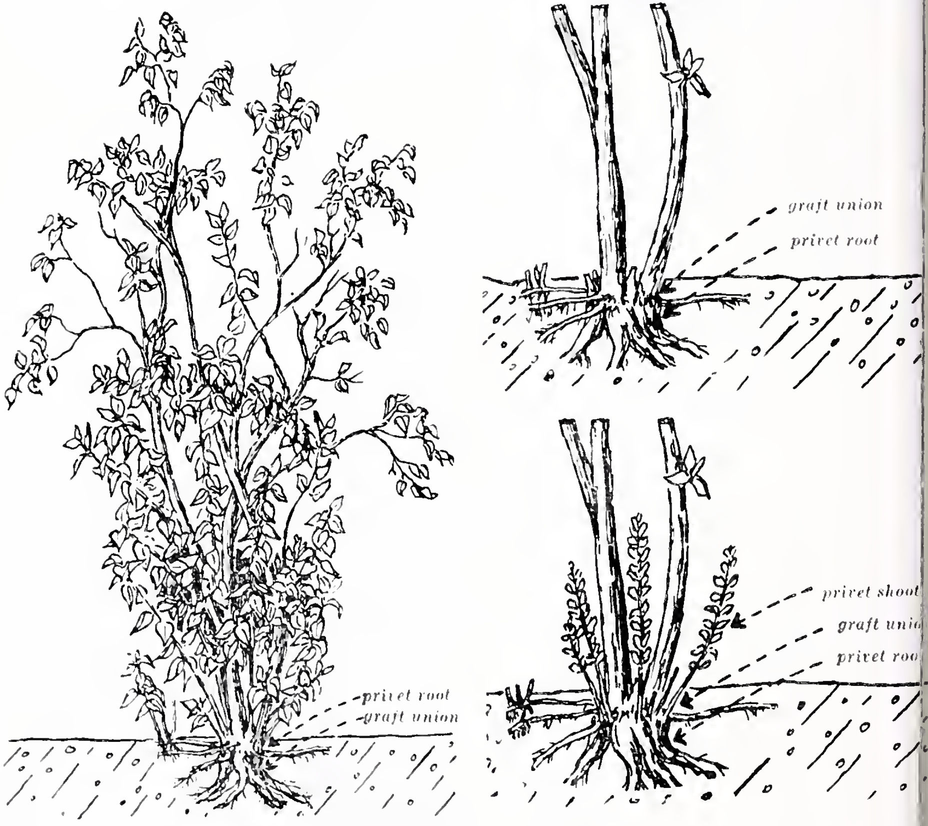


NOTE ON REJUVENATING GRAFTED PLANTS

In order to develop such interesting plants as the Schwedler Norway maple, Koster blue spruce, purple-leaved plum, Japanese maples, and many other forms, the nurseryman has had to graft the desired form on the root of a different plant —one that is closely enough related and particularly vigorous. This practice does not necessarily make these plants less valuable; but the plants do require slightly different treatment in pruning.

In cutting back old plants of these grafted forms, it is dangerous to be too severe. If too much of the top is cut out at one time, the root (which was chosen because it produced vigorous growth) will send up branches of its own kind. If a grafted lilac is cut back too severely, the privet root is likely to send up new growth—of privet, of course, not lilac. If a purple-leaved plum is cut back too much, the root will send up branches with green leaves.

Therefore, if it is necessary to revitalize a grafted plant, the renewal pruning should be done in stages. No more than a fourth of the old growth should be cut out at the ground level at any one pruning. Another fourth of the old growth may be taken out only after the young growth (which follows the pruning) has reached about a third of its mature size. This slow method of revitalizing does not upset the important balance between roots and tops.



Grafted lilac "turning into privet" after too severe pruning.
Left: Old bush in need of pruning.
Right, above: All young growth pruned away; old wood cut back too far.
Right, below: Privet shoots coming up from vigorous privet root; no new growth on lila

WITHIN THE BROOKLYN BOTANIC GARDEN

"A time-budget garden" was the theme of the Botanic Garden's exhibit at the International Flower Show in New York, March 16 to 21, 1952. The plan below and the photograph on the next page show a small pleasure garden as it might appear in late May or June, and a work garden to help maintain the pleasure garden with a minimum of expense.

The Work Garden

A properly organized and equipped work garden can afford many hours of enjoyable entertainment and accomplishment.

In the little work- and storage-house are bins for winter storage of potting soil, peat moss, and leaf mold. It is possible then to do potting and flatting on the late winter days when the weather is not too cold.

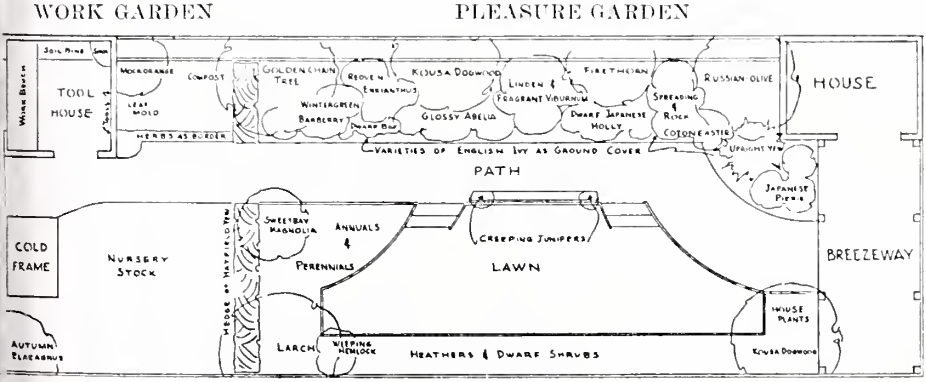
Good topsoil can be made from ordinary soil by the addition of humus and chemicals. Sandy or clay soil can be made pliable and nutritious and a good water holder by the addition of about one-third peat moss, leaf mold, or compost. Several days before using, the addition of a cup of 5-10-5 fertilizer to each bushel of soil, will round out the mixture. This is a good potting, or flatting, soil for most outdoor plants.

The little work garden or nursery might go through several stages of development. If a gardener decided to grow his own plants, he would find that most of the available space for a few years would be taken up largely with plants for the shrub border.

As these plants were moved out to their permanent positions in the shrub border, space would become available for plants to fill the bright spots. As more plants were moved into their permanent locations, the gardener might start a cutting garden, or perhaps a kitchen garden. Plants for seasoning or salad might be thyme, sweet basil, parsley, tomatoes, lettuce.

The Pleasure Garden

Some plants used here are extremely slow-growing and expensive to buy in the sizes shown. This garden is pictured as it might look ten or more years after the original planting. If a finished look is necessary immediately after planting, one must be prepared to pay for it; or begin with cheap fast-growing shrubs, at the same time buying small plants of the choicer, slow-growing kinds such as are



Alice Recknagel Ireys

N. Y. Times

Pleasure garden exhibited by the Brooklyn Botanic Garden at the International Flower Show, New York, 1952.

shown here and keep them in the little nursery. As the fast-growing items outgrow their spaces in the garden, they may be replaced with the slower-growing materials which have been growing in the nursery.

A suggested round of color for the bright spots might be bulbs for early spring followed by fibrous-rooted begonias, and English daisies from the cold frame, then tender perennials such as geraniums for sun, impatiens for shade, annuals such as dwarf dahlias, marigolds, pansies, and snapdragons, and perennials such as iberis or chrysanthemums.

House plants brought out of doors and plunged in the light shade in a corner of the garden will need less care during the summer months and will be ready to bring inside again in the fall.

The edging of brick around the lawn eliminates time-consuming edging work.

Summer mulches before the heat of July and August, reduce back-breaking weeding to a minimum. Mulches such as peat moss, sawdust, wood shavings, spent hops, or partially rotted leaves hold water and reduce watering to a minimum.

Soil soakers in plant beds, turned on slowly and allowed to run all day two days during a week, solve the problem of watering shrubs and flower beds.

BROOKLYN BOTANIC GARDEN

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I.R.T., West Side (7th Avenue or Broadway-7th Avenue line), downtown expre marked "New Lots Avenue" or "Flatbush Avenue," to Eastern Parkway-Brookly Museum Station.

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B.M.T., Brighton Beach line, downtown express or local to Prospect Park Statio

By Automobile:

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ROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

AUTUMN
1952

ock and Wall
Gardens

Design
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Plants
for Various
Situations
nd Localities

NEW SERIES
8 NO. 3

PLANTS & GARDENS

Kerria japonica

Vol. 8 **Autumn, 1952** No. 3

CONTENTS

Cover—A well designed and suitably planted rocky slope. *Roche.*

Page
Director's Letter 177
Rocks in Garden Settings 178
The Rock Garden in the Landscape ..... Viola Briner 184
Designing a Rock Garden ..... M. Walter Pesman 190
Soils and Water in the Rock Garden ..... E. Bissett Lovelock 194
Wall Gardens ..... Victor H. Ries 196
Rock Plants for Beginners—and for Others ..... Stephen F. Hamblin 202
Rock Garden Clinic ..... Victor H. Ries 210
Native Northeastern Plants for the Shady Rock Garden ..... William C. Horsford 218
Alpine Plants from the Rocky Mountains ..... George W. Kelly 225
Rock Gardening in the South ..... Elsie N. Hassan 230
Rock Gardening in California ..... Virginia Stewart 236
A Rock Garden in the City ..... Alys Sutcliffe 241
Herbs for the Rock Garden ..... Freda J. Shoupp 246
Shrubs for the Rock Garden ..... Richard J. Darling 249
Alpine Bellflowers ..... E. Bissett Lovelock 254
Propagation of Rock Garden Plants by Cuttings ..... D. C. Kiplinger 258
Germination and Growth of Certain Rock Garden Plants ..... Lela V. Barton 262
Control of Pests in the Rock Garden ..... Ralph H. Davidson 265
Within the Brooklyn Botanic Garden 270
Among the Contributors to this Issue 272

Victor H. Ries, *Guest Editor*
Hester M. Rusk, *Associate Editor*
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BROOKLYN 25, NEW YORK
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Autumn 1952

Civilized man has been making gardens for thousands of years; and just as in everything else, there have been many changes in fashions. Rock gardens are no exception, and for a time they were overstressed. They were frequently built where they did not belong, and sometimes consisted of a hodgepodge of rocks and an equally indiscriminate collection of plants. Many such gardens are still in existence today, and even a few new ones are built each year!

The charm and appeal of rocks in the landscape gives rock gardens a real reason for being. But this does not mean that a boulder-strewn field or hillside is the ideal thing to copy in the garden. It is the ledge or rocky outcrop one discovers here and there in the wild that offer the best suggestions for layout. And only certain plants make suitable companions for the rocks. These are the elemental ideas for those who aspire to a rock garden.

Guest Editor Ries and his corps of carefully selected authors have filled the 100 pages of this Handbook on Rock Gardens with ideas galore, and good solid "how-to-do-it" information. Suggestions on design are particularly important, but every page should be helpful in solving rock garden problems.

Sincerely,

George S. Avery Jr.

Director

McFarland

Along a sloping border, or where a break is indicated in a wide expanse of lawn, a low rock garden is suitable. Tall trees and stone walls can help to frame it; and dwarf azaleas together with a few carefully selected perennials are all that is needed for plant material.

ROCKS IN GARDEN SETTINGS

Whether used in steps, walls, walks, or conventional gardens, carefully chosen rocks have a place. They must be a part of the over-all design and must be used with restraint. No less important are the plants that go with them, as the accompanying photographs illustrate.

Simple stone steps improve the appearance of a broad grass ramp that leads from one part of the garden to another. Small rock plants are at home in chinks and crevices and soften the appearance of the stones.

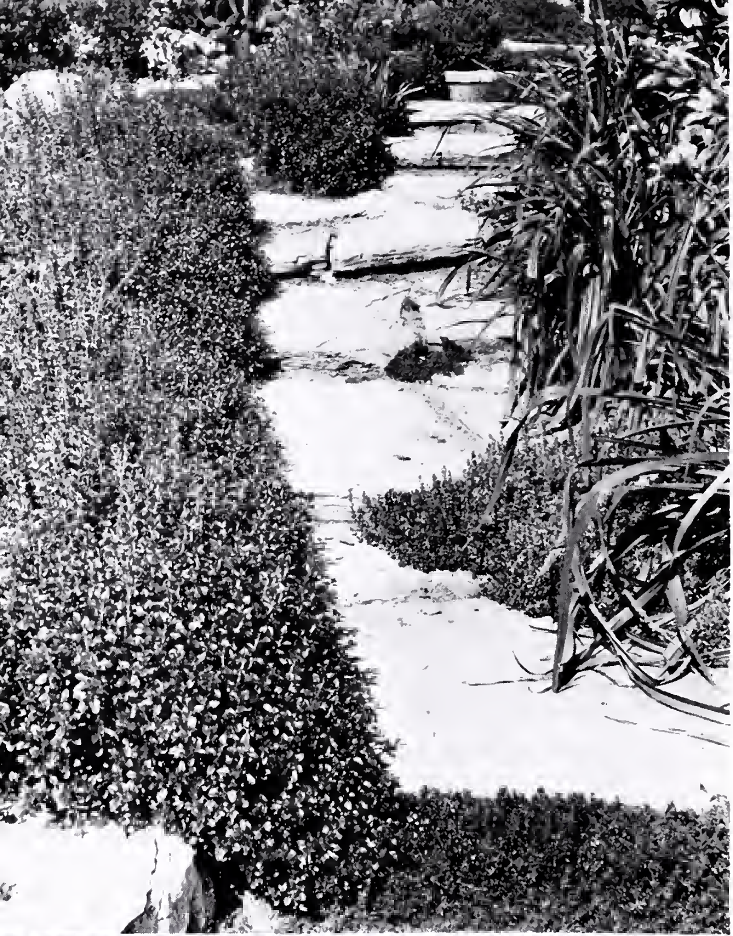
Ries

Ries

Large slabs of rock overhanging the back of a concrete pool help produce a naturalistic effect. In this case a single ledge of weathered limestone fits delightfully into an otherwise level yard or garden.

McFarland

Formal steps, which otherwise might be too severe, can be mellowed by the use of low-growing plants such as creeping speedwell (*Veronica repens*).

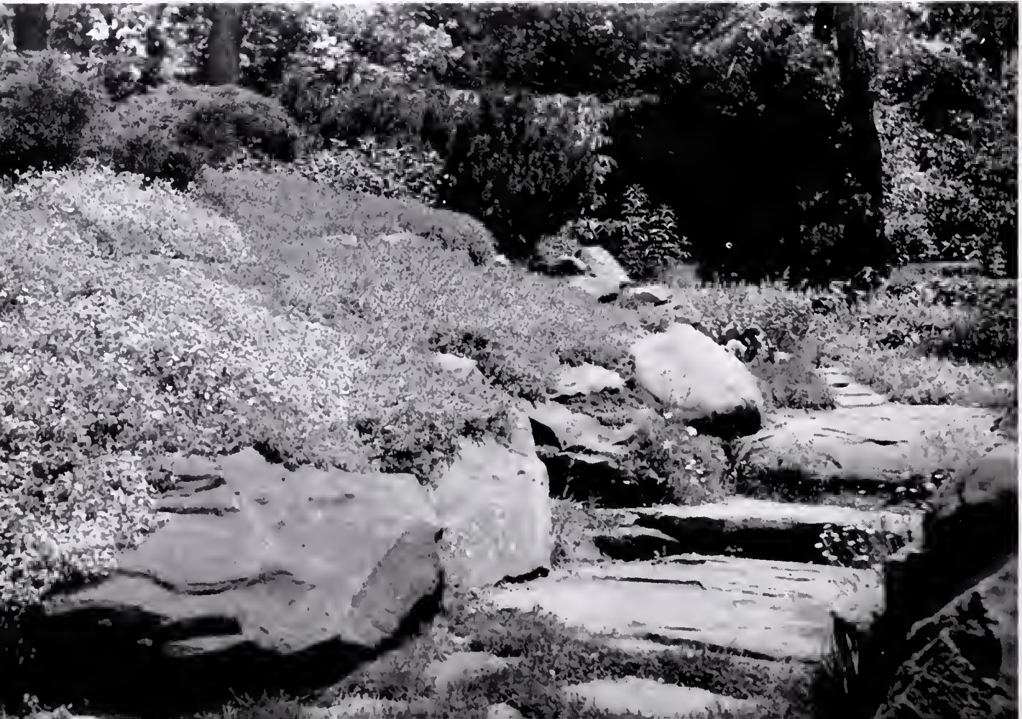


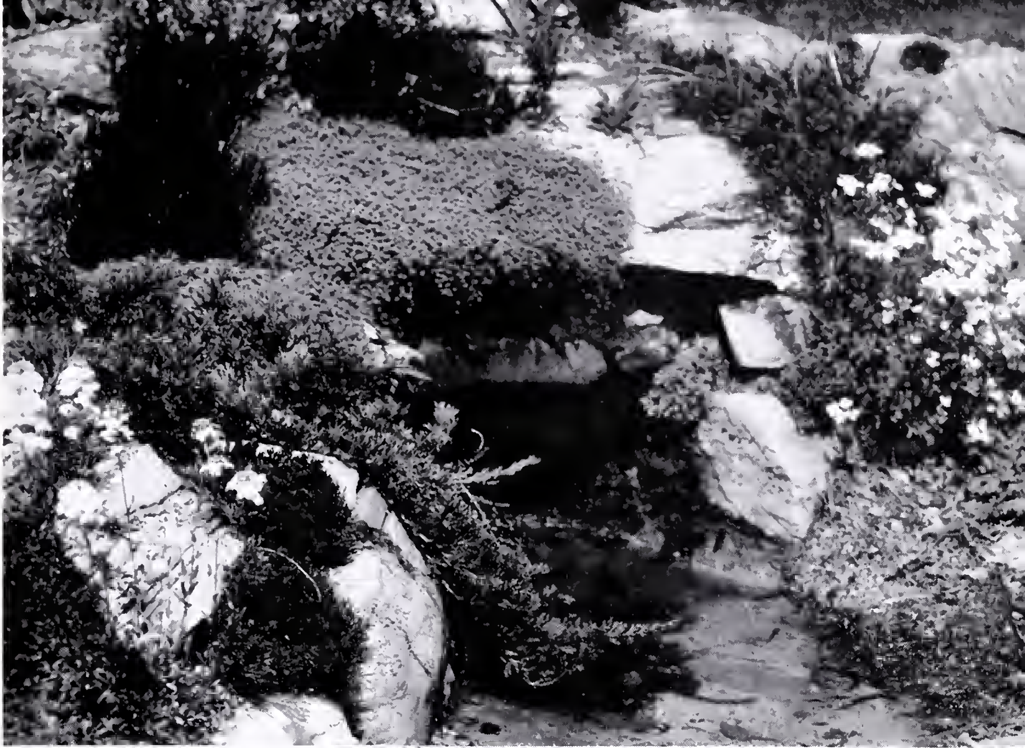
McFarland

Informal stone steps readily lend themselves to many different types of plantings. Germander (*Teucrium chamaedrys*) has the advantage of rapid growth and generally stays green throughout the year. If kept within bounds, it is a good edging plant for walks and steps.

Occasional large rocks, whether for walk, steps, or edging, give a massive dignity to rock garden design. Mats of low-growing plants help give a natural effect.

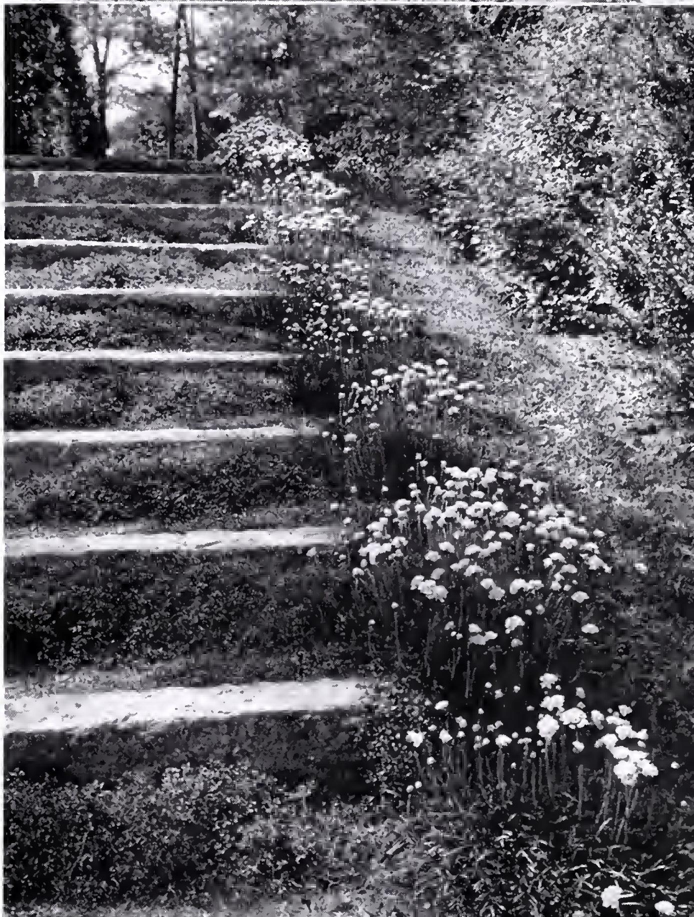
Ries





McFarland

A small cavern and pool give the effect of a natural spring among the rocks.



McFarland

The harsh newness of these steps has been relieved by thyme; the border is defined by thrift (*Armeria maritima laucheana*).

Ries

Rock walls, low or high, may be used to advantage in many situations, and have charm when suitably planted. This low wall along the driveway is easier to care for than a grass terrace.

McFarland

This informal high wall, planted with dwarf goldentuft (*Alyssum saxatile compactum*) and other rock plants, gives garden beauty to a structural necessity.

Roche

A more formal wall can be softened by such plants as rock-cress (*Arabis*) and moss-pink (*Phlox subulata*).

A steep slope adjacent to a house often calls for a simple rock planting. In this case Swiss mountain pine (*Pinus mugo mughus*), garland flower (*Daphne cneorum*), and snow-in-summer (*Cerastium tomentosum*) make up an interesting group of plants. To keep Swiss mountain pine low, the new growth is pinched back to about 2 inches each year.

Ries

THE ROCK GARDEN IN THE LANDSCA

Ries

This simple wall garden furnishes a transition between house and garden

A little history, and concrete suggestions for making and placing numerous kinds of rock gardens

Viola Briner

THE appeal of rock for the gardener is as natural as the rock itself, and its use in gardening is as old as gardens themselves. It remains only for the gardener to become familiar with his basic materials—earth, rock, water, and plants—and to combine them in such a manner that he satisfies his desire for an aesthetic expression of his relation to them. It remains only for him to make a garden!

A garden specifically implies an enclosure furnished with plants. The enclosure may be defined by four simple cor ner stakes, by a solid wall, or by anythin intermediate between the two, either struc tural or consisting of vegetation.

The enclosure may be geometrical i shape—rectangular or square, for exam ple—or it may be irregular, following th lines of streams, hills, or roads. The par ticular form given to it is determined b many additional considerations, such a climate, the function it is to serve, and th individuals concerned.

Usually a building and other structures are present, and the problem of the designer is to relate them pleasantly to the grounds. Rocks, which are closely related to both the land and the architecture, are among the best mediums for working out a transition from grounds to structures.

A Background Résumé

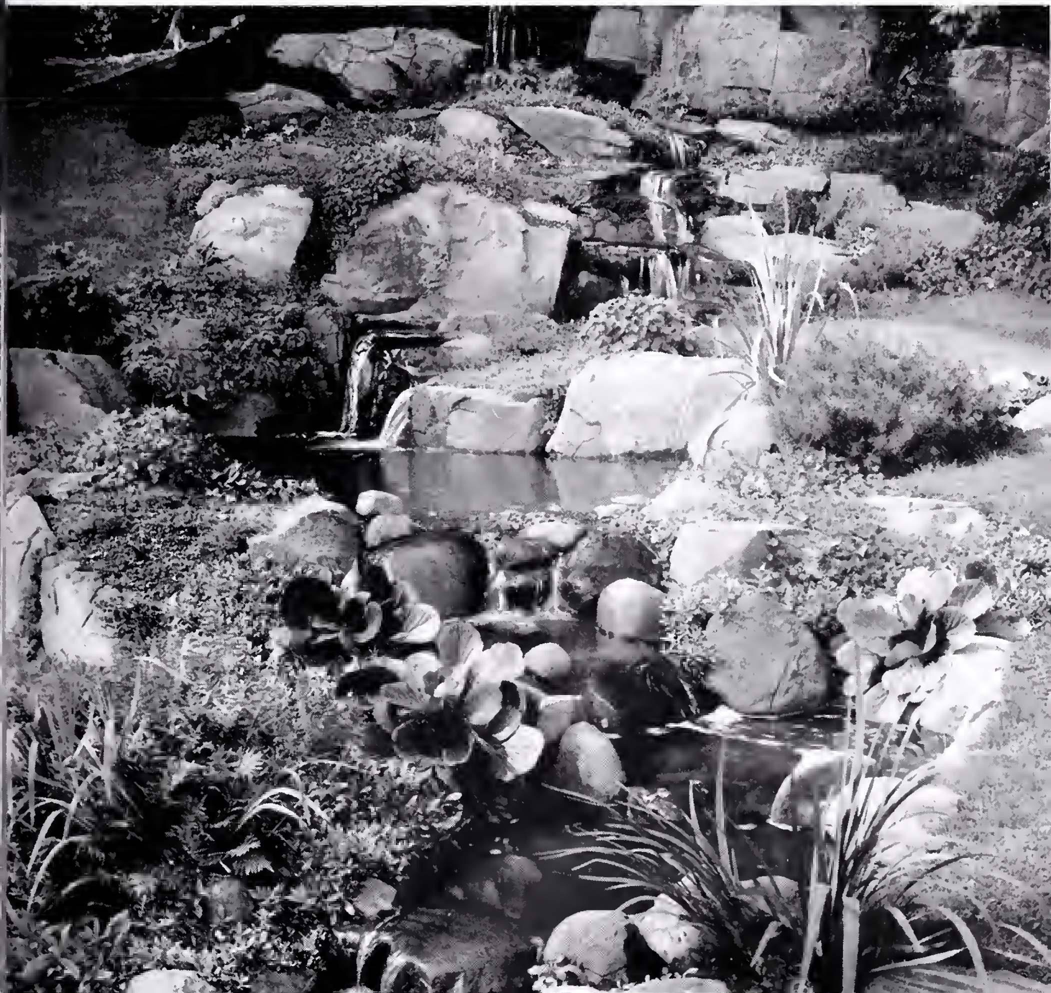
Early gardens of all parts of the world have in common the use of rock. In some instances, such as the famous hanging gardens of Babylon and the walled gardens of the cloisters, rock was used more in its architectural role; while in gardens of Japan and in English landscape gardens it was used more as it appears in natural landscapes.

Among the most notable gardens in the history of outdoor art were the villas of Italy, where the terraced hillside gardens partook of the nature of both the land forms and the architecture in a most skillful manner which has never been equaled elsewhere. Even the ruins of these gardens will bear much study of the combining of the exigencies and pleasures of man and his interpretation and application of the forces of nature.

There, advantage was taken of the geological aspects of the Italian hillsides in creating a garden setting that was ideal for the native ornamental and useful plants. Cypress and plane tree, vineyard and olive orchard fitted in perfectly, along with potted citrus specimens. Water from

A naturalistic rock garden with pools and falls.

Harold Haliday Costain
Frederick Leubuscher, L. A.



higher levels was cascaded through the gardens in a magnificent display.

The civic architecture of the seven hills of Rome was the seat of the social factors responsible for producing these villas, which were at once a retreat and a social stronghold—gardens both ornamental and operative.

The French became the next aspirants to gardens on a grand scale. Here was another example of an exceptional handling of the local terrain. On great expanses of level ground gardens were laid out in geometrical fashion, seeming to extend to infinity. The patterned parterres were viewed from upper rooms in the châteaux, while broad avenues and *allées* made ample promenades for the gentry. The social entourage was the real *raison d'être,* and without the throngs of people present the gardens seemed vast and empty. Unlike the Italian villas, these gardens denoted a mass social demonstration rather than independent living units.

Eventually the artificiality of this form of gardening produced the inevitable reaction—a definite reverse. This was evident both in France and in England—to which country the grandiose scheme had progressed. The close relationship between landscape or garden design and other forms of art is noticeable in the paintings of the leading artists of the day; the artists painted landscapes of a lyrical and romantic nature, and these were copied by garden designers.

Although the results satisfied the desire for a complete change from formality, it was really an overbalancing movement, without due regard for sound design. This state of inorganization was dressed up by all manner of novelties, exaggerated natural features, and sentimental contrivances for special play upon the emotions.

In due time the desire for emotional effects was appeased, and full compensation was made for the formalism of the preceding period. The next trend is found in the English landscape style of gardening, still avoiding formality but demanding organization in design. Here again natural land forms and the related materials of rock and water played important parts.

With the advent of the Industrial Era and a loss of touch with the open country, urban America was quick to adopt a similar style, which was in good keeping with our continental frontiers. The tradition of the gardens of the small landowner of the Tudor period and the cottage gardens of the Elizabethan period—both with rock walls and paved courts—had accompanied the colonists to America and characterized the small gardens of the Colonial and Federal periods.

The use of rocks in a garden demands suitable planting to incorporate the rocks in the design. Out of the foregoing periods came a concentration upon new and specialized kinds of rockeries—such as alpine gardens and moraine gardens, which were exacting as to construction and planting.

This in turn led to greater efforts in searching far and wide for more kinds of interesting rock plants, and so in time the rocks became secondary in interest. It was then the collection of plants that was the pride of the gardener; the rocks were selected and arranged accordingly. Rock gardening was a recognized art among garden enthusiasts—one that held a special charm and challenge.

The early part of the twentieth century saw in this country the beginning of the great garden club movement, which was especially strong among owners of smal properties. Rock gardening was one o the most popular forms of gardening. As might be expected, with many novices engaging in an exacting horticultural attempt, results were many times disappointing. Eventually the horticultura side of the venture was neglected and activities centered once more upon the rock themselves. From that point rock gardening was a thing apart from horticultura skill in the majority of cases.

The novelty devices of the Romanti Age had no superiority over some of th twentieth century monstrosities. Rock were often selected because of high colo or other striking features. They wer placed in conspicuous arrangement in prominent parts of the garden. Planting was often reduced to weedy types of plants which were able to thrive under any conditions; and this weediness eventually became the fate of the rock garden itself, as it was abandoned for some more satisfying form of gardening.

A return to the use of rocks in gardening is now appearing in a typically modern trend. The city dweller and the villager alike are confronted with the same complexity of modern living and share the same desire for a return to nature, even though only in a simulated manner. This desire is expressed through architectural notes in the rambling ranch type of house, picture window, and barbecue. Terraces, walks, and walls are built variously of stone slabs or rough masonry, or as a continuation of the construction of the house. Now rocks are being used to make a transition from architectural forms to land form, rather than from land form to architectural forms as in the recent past.

Fitting the Rock Garden into the Landscape

Under present-day handling, where the naturalistic type of rock garden is being used, the rock garden is an integral part of the landscape design and not an exhibition piece. It is usually made to develop some particular form already existing within the area. Ravines, ledges or banks, grotto and pool are common examples.

A lookout point is especially suitable for a boulder garden. This garden may consist of one large boulder with perhaps a few in smaller sizes. If it is in a sunny place a planting of rough-mown grass and such plants as bittersweet, goldenrod, and daisies, creates a simple reminiscence of the abandoned meadow which it simulates. The essentials of a retreat may be supplied by a properly prepared approach, so that upon entering the boulder garden one has the sense of having stepped into a remote field. A rustic stile or a weathered gate can help to create such an illusion.

The element of a retreat is likewise the keynote of success in a rock garden such as a ravine or a rocky ledge. It should be partially concealed as one approaches it and should have a casual transition from the opening of a definite trail or pathway. It is the more interesting if it is first viewed from some special vantage point.

Depending upon the size of the area and the possibilities already extant, the rock garden proper may be concentrated at one point or may be developed as a series of ledges or outcroppings. If the rocks are already present, as in an outcropping, usually the only thing necessary is some careful selecting; but if the rocks are to be introduced, special care should be taken to observe the natural contour of the terrain. If there are changes in grade, the rock courses might be interrupted (with shrubby planting between) and a number of broad steps fitted into the topography to bring the path to the new grade. With steep grades, the steps may proceed at right angles to the main direction of the path or trail, turning at a landing area part of the way down. Plants indigenous to the locality, chosen carefully for the proper scale, usually provide the most satisfactory effect in planting.

A grotto, or overhanging rock, immediately suggests the presence of water and so makes an ideal spot for the construction of a pool. Such a feature should receive careful treatment even in the informal area of which it is a part. The introducing of the water course offers a pleasant challenge to the designer to make the water appear and escape as naturally as possible. The volume is unimportant: equally interesting effects may be obtained from a cascade, a quiet stream, a trickle, or even a slow dripping; although, of course, the different types of water course require different handling. A grotto or a pool need not be completely obscured from the main part of the garden, and some indication of its presence makes it more interesting.

Banks that result from building or grading operations may frequently be adapted for rock gardens. In fact, a rock garden may be the means of solving a difficult problem in bank planting or bank control. Usually in such a situation a selection of rock plants from a seed catalog may be used to advantage in starting the garden and may easily become a great fascination.

There are few situations that allow a mound type of rock garden without its appearing artificial and stereotyped. It seems most suitable in a Victorian setting or in connection with an outlay of bedding plants.

Since all scenic effects in nature are produced by natural forces (wind, water, gravity, and frost action, for example) inspecting a landscape design in terms of these forces is a good test of its success. Wherever the action of water is indicated, a definite sense of continuity should be evident. The relation of rocks to earth, water, and plants should be natural and simple, as though the rocks had arisen from the physical environment and assumed a stable angle of repose, making a perfect setting for the plants growing there. Exposing weathered rock faces, rather than freshly cut or broken ones, gives an appearance of age.

The Architectural Scheme

The same sort of test holds equally true in judging a piece of rock work that accompanies architectural forms. Although the personal and social factors are present in both types of rock garden, the environs of man-made structures should recognize the use of square and plumb line. The workmanship of man should be shown to have controlled the materials. Any type of rock work should be in good design with or without planting.

Terraces should be designed as a transition between dwelling and garden, partaking of the nature of each. Building materials should be repeated or related. Built-in planting boxes are an excellent means of effecting a functional transition. Masonry plant boxes at the building side of the terrace, and openings for planting in the paving at the garden side of the terrace, are in good keeping with modern design and are most convenient for integrating indoor and outdoor living areas. Tubbed or potted woody plants are both a means and an end in terrace plantings.

The transition is carried to the rest of the garden by steps, walks, or walls—ending, perhaps, at the barbecue or the swimming pool, or at a gateway leading to some other (and differently treated) part of the garden.

On a small lot an example of materials might be a brick house, terrace and steps paved with a pattern of brick and sandstone, and a brick walk leading to an outdoor brick fireplace with a generous hearth paved with sandstone.

Another combination might be a frame house with stone foundation and outside chimney, grass terrace retained by a stone wall, and a continuation or repetition of the wall in some other part of the garden, in sight of the terrace—or even emanating from it. A narrow stone curbing around raised planting beds or borders could be used consistently in sections near the house or throughout a small garden.

Even a very small court garden, completely walled and paved and attractively furnished with plants, can give a tremendous amount of garden charm and satisfaction. Fountains, sundials, and other ornamental features should be simple and should be placed with academic consideration.

In the architectural setting, the nature of the planting should be suggested by the rock work just as in a naturalized scheme. Built-in planting boxes are suitable for either evergreens or flowering shrubs. These should be treated as a par of the foundation planting. The attractiveness of paving is greatly enhanced by the presence of suitable rock plants in the open joints between pieces of stone. Color, fragrance, and textural pattern ar obtained in this way.

Rough walls may be adorned with wide variety of plants adapted to suc conditions—provision for planting space having been made, of course, at the tim of construction.

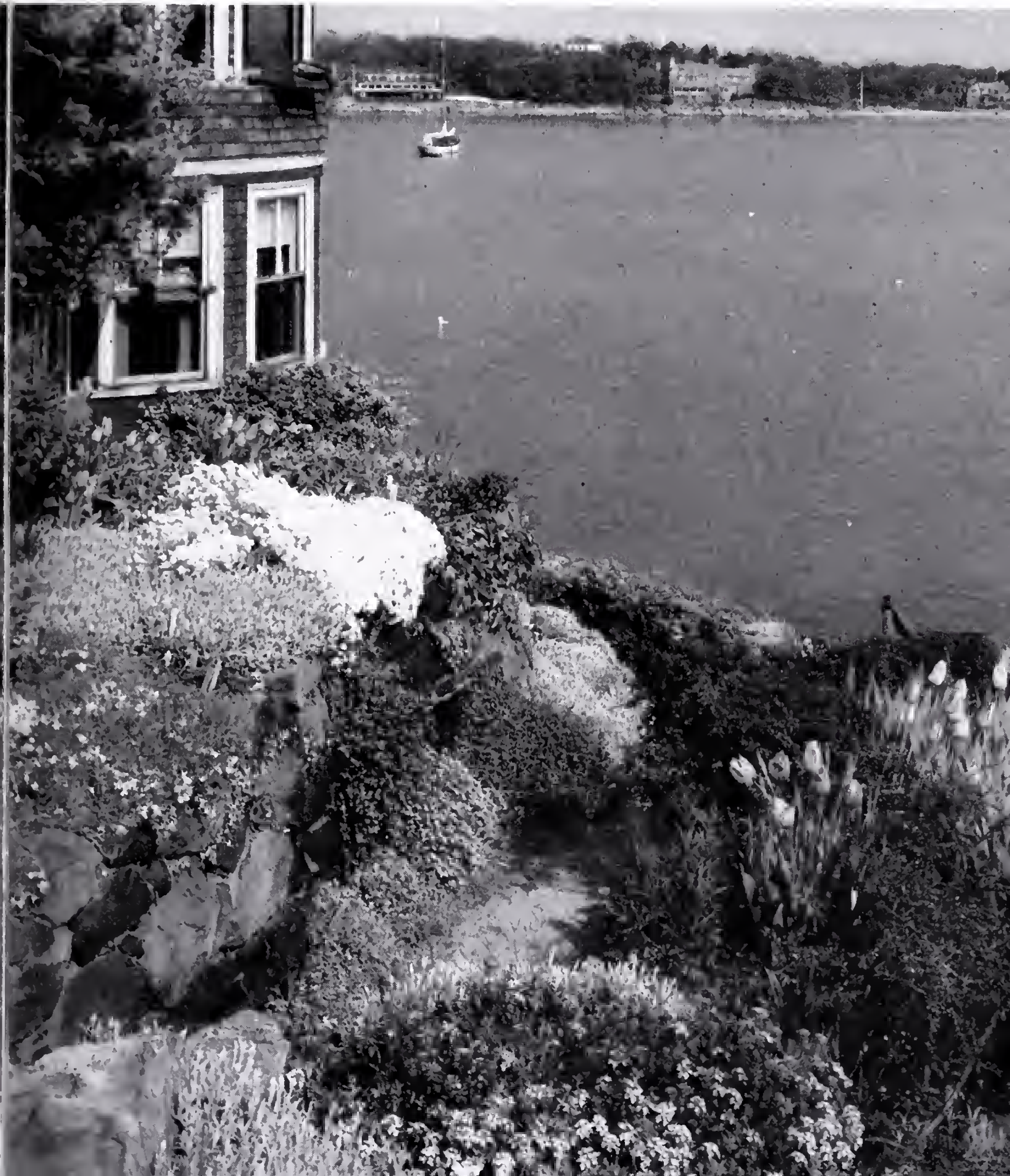
If a wall is laid with mortar, the plant ing may be staged in front of it by the use of espaliers or plants trailing from above or both.

With a retaining wall that is near eye level, a modernistic effect may be produced by putting on top of it plants with bold form, to be seen silhouetted against the sky. Plume-poppy (*Macleaya cordata*), umbrella-pine (*Sciadopitys verticillata*), and yucca are desirably dramatic.

Endless combinations suggest themselves when a plant list is studied with the architectural scheme and the manner of living in mind.

A rock planting is the only simple and attractive treatment for this steep situation between house and harbor.

McFarland



Ries

A reminder of the days when it was commonly thought unnecessary for a rock garden to be **designed.**

DESIGNING A ROCK GARDEN

How to make it look natural and convincing—as if it had been there for thousands of years

M. Walter Pesman

ONE might think that Denver, the center of the Rocky Mountain Region, would be the logical place for the nation's outstanding rock gardens; the source material for a good rock garden is right in our front yard, so to speak. Any good student of nature should be able to see the typical make-up of a rock formation, the way soil has accumulated in and around it, and how plants have found a place to nestle themselves against the rocks. It all seems simple and evident—in the mountains.

A rock-pile monstrosity, the "penitentiary type" of rock garden.

Author courtesy

Poor Types

In spite of this, good rock gardens ar few and far between in this region. O the other hand, it is amazing how easy i is to build a monstrosity and call it a roc garden. It is even possible to classif these well-meaning attempts. There i the denture type, resembling a neat se of huge false teeth placed edge to edge The tombstone type has more irregularity large and small upright stones loom up i

McFarland

Skillful design has made this pleasant slope into a naturalistic rock garden.

unexpected places, gaunt and morose. The penitentiary type seems ready-made for any convict to go to work on the rock pile. The collector's pride consists of a heterogeneous assemblage of stones, gathered from various places, either locally or brought from many parts of the country or of the globe. Any one of these types may be decorated with colorful art objects, such as tiny fishermen, huge cranes and storks, bridges and windmills, gnomes and toadstools in pottery. Occasionally we may find an attempt at re-creating an entire mountain in a back yard, say Pikes Peak, with miniature cars climbing up to the top, or the Matterhorn with precipitous slopes.

Good Kind

A successful rock garden, on the other hand, looks like a bit of alpine growth in its natural setting. The rocks crop out of the surrounding soil and are covered by alpine growth, small and dainty, to an extent of about 50 or 60 per cent of their surface.

To make a rock garden convincing, one should carefully consider the relation be-

This outcrop of dolomitic limestone was labeled in its natural setting, carefully excavated, and re-assembled in almost its original formation. *Ries*

Author courtesy

Man-made after Nature's specifications.

tween the plants and their environment. For example, water-worn rocks suggest water-loving plants; typical alpines go with a gravelly well-drained surface; most cactuses seem out of place with such plants as wood-nymph, or one-flowered shinleaf (*Moneses uniflora*); or kings crown, or stonecrop (*Sedum integrifolium*). Above all—and this is hard to make the average gardener see—a rock garden should look as if the rocks had been in place for at least a hundred thousand years. Nature leaves no wobbly rocks (in general) but distributes a goodly layer of soil among them. Nature does not stop a ledge of rocks abruptly, but repeats it in a continued line beyond.

Basic Requirements

All of this may sound like a lot of theoretical generalities. Let us try to apply these ideas to the construction of an actual rock garden in the Mountain States region. Two things are basic: (1) the proper situation for the proposed rocky ledge; (2) the proper rocks to place there. All the rest is detail, including the choice of material to plant.

Situation. A flat piece of ground, surrounded by flat ground, is an almost hopeless situation for a rock garden; yet I have seen one or two cases where an excavation in one spot, piled up in an adjoining place, did finally present a convincing contour—helped, to be sure, by a solid screening of the surrounding territory.

Any kind of slope, however, can be utilized, if transformed into a naturalistic outcrop. Excavated soil piled up beyond emphasizes a slope to unsuspected proportions. The soil should be the type that most rock plants prefer: a mixture of good garden loam, sharp sand, organic material, and stone chips.

Kinds of rocks. The best way to create a convincing rock garden is to use one type of rock only. Sedimentary rock is easiest—sandstone, shale, or limestone; it lends itself to recurring ledges, just off the horizontal; it creates natural plant pockets; it is apt to have some lichens to begin with. Metamorphic rocks with definite lines of cleavage (such as marble and slate) are not too difficult. Typical volcanic rocks in fantastic shapes require the skill of a combination artist, geologist, and horticulturist. Anyone that fits that specification should by all means try volcanic rocks.

Design

If a natural ledge can be found that can be moved—all to the good. We have seen cases where such an outcrop was actually labeled on the ground, carefully excavated, and re-assembled in almost its original formation. That, however, is one of those unusual circumstances that seldom happen.

The other possibility is finding a rock formation with a number of removable large rocks—preferably with lichens—which can be used in the rock garden in a new assemblage. Such a new formation, however, should be carefully **designed.**

When a rock garden is being constructed by a professional, the first stages of the work are particularly interesting. Anyone paying him by the hour might have misgivings about his diligence. The assembled rocks are laid out in the position in which they are to be used, each one separately, or in combinations where they look their best. Then the artist seems to go into a trance, sizing up the rocks available, sizing up the ground in which they are to be placed. He may try a few of them tentatively, without much excavation. A whole forenoon may well be spent on this seance; but it proves to be time well spent. After that the artist knows these rocks as a mother knows her children, familiar with all their peculiarities—their good sides and their shortcomings. He has formed a general **design** according to which the rock garden will be constructed.

It is most essential to have a number of very large rocks: they form the backbone of the design; in turn the smaller ones are fitted into the design thus created. In other words, the picture is created step by step. Some of the rocks must be partly buried under the surface. In any case many soil pockets are left between them, an ideal place for the alpines to be planted. The modeling of the soil is just as important as the placing of the rocks.

After the whole thing is in place, the final result should be one of *inevitableness*, as if Nature herself had uncovered the rocks in spots, blanketed them in others. What man constructs must look as if Nature had left it in place for centuries. It should impress one as being revealed rather than man-made.

Finally comes the joy of planting, each little gem in its well-considered spot. But that is a story in itself. Let us stop here with the original creation of the miniature mountain nook.

A convincing bit of nature in a garden, designed by the author. *Author courtesy*

McFarland

Gentians cannot endure lime.

SOILS AND WATER IN THE ROCK GARDEN

What to do and what not to do, under varying conditions, for the best success with alpines

E. Bissett Lovelock

THOUGH not always recognized as such, drainage is the main problem affecting the alpine gardener; and it is in this respect that most amateur gardens fall short of the ideal.

Poor Advice

Rubbish. Most of the textbook advice on drainage is fallacious or at least is based on theory rather than on practical experience. Few books are written on the subject without urging the reader to start by digging a large hole and filling it with rubbish. In sandy soils such a practice is unnecessary; in stiff clay it is a positive danger. Experiments on a small scale will show that such a hole, surrounded on every side by a stiff impermeable medium, will fill with water and the water remain there until it turns stagnant. The effect of a permanent pool of stagnant water at the base of a rockery can be imagined.

Drains. A refinement of this advice is the suggestion that drains be laid down to carry off the stagnant water. This is expensive, and in any case is not effective unless the drainage leads into a main drainage system that will carry the water away. Otherwise the deepest drains fill with stagnant water in time and show a negative return for the time and money spent on them. In any case it is not long before the clay seeps into the drains and regains possession—as clay does quickly. This, as we have shown, is really an advantage and has probably saved many rock garden from failure.

Gravelly Soil

Leave alone. Gardeners as a race lov complexity; but in the matter of drainage the cure lies in greater simplicity For the person lucky enough to hav gravelly soil, the solution lies in doin that most difficult of all things for th gardener—nothing at all. This advic must be taken literally; all too man gardeners with the blessing of gravell soil spoil it by adding peat, leaf mold and even cow manure. Adding such materials is a policy so constantly advocated by experts on flat gardening that i is hard to realize that the majority o alpines are ideally suited by dry, hungry and even thirsty soil; and that to do anything to clog the soil is to create rathe than to solve problems.

Clayey Soil

Most gardeners are less fortunate, however, insofar as their gardens contai clay to a greater or less extent. Though an odd plant or so thrives in it, clay i the main enemy of rock plants, and it presence is the main reason why, in man gardens, all sorts of delightful plant flourish one summer and disappear before the next comes.

Make new soil. With soil of this type the ideal is to keep as far away from it as possible. A counsel, perhaps of perfection, as it involves expense, is to build the rockery entirely of imported soil, made up to specification. An ideal mixture is equal proportions of unwashed river sand, sphagnum peat, and a good friable loam. Unwashed river sand is hard to come by but contains useful plant foods; tests made with difficult alpines have shown this medium to have an advantage over other kinds of sand, in every case.

Ordinary builder's sand can be substituted for river sand; but if the question is one of expense, almost any indestructible material will do for drainage. Ashes (which should be weathered for six months in the open), clinkers, brickbats, stones, and even broken glass and pottery appear to be of equal value. Ordinary peat can be used instead of sphagnum, or moss peat, though it is not so suitable; leaf mold will do instead, possibly in slightly smaller quantities, if it is very well rotted.

Finally, garden soil can, if necessary, be substituted for the loam. We are dealing with soil that is substantially clayey; and where this is the case, the proportion of drainage material must be greatly increased. A proportion of 5 pails of drainage material to 1 of soil is not too much; it can indeed be exceeded where the clay is particularly sticky. The value of such a mixture on normally difficult clay can be endorsed from the writer's own experience.

The main difficulty lies in breaking up the clay in order to mix it efficiently with the drainage material. The easiest way to do this is to use exclusively topsoil from other parts of the garden. This again is a counsel of perfection; all too often the topsoil cannot be spared and the clay has to be dug out of a hole. Then the clay must be spread out and left to weather for six months or so; if it is mixed up in lumps, in lumps it will remain to the garden's lasting detriment.

Lime is often recommended to improve clay soil, but opinion seems to be veering against this method. It is certainly a stand-by and is appreciated by some plants; but the number of these is now known to be much smaller than was at one time thought. Whereas the lime-lovers do tolerably well without it, the lime-haters will not tolerate it under any conditions. As the lime-haters include many of the most popular rock plants—gentians, heaths, and rhododendrons, to name three—lime should be introduced only by persons who are certain of their ability to do forever without these plants. It is important to understand that lime spreads in all directions except upwards, in the course of time. Thus in a rock garden that has been limed, the only safe place for the so-called lime-free pockets, invariably recommended for lime-hating plants, is on top of the rockery—which is just where these plants do not grow well.

If the soil consists of the elements named above and the rockery is reasonably high, a clayey subsoil will be no disadvantage. Water will drain through the rockery itself and the plants will accommodate their roots there. At the most it is necessary only to give the level of the surface soil a slight slope. Actual experience shows that given a sunny exposure, there is little in the alpine world that cannot be tackled with good chances of success.

Drainage:

- Know your soil type before planning drainage.
- Do not use drain tile unless it leads into a main drainage system.

Soil:

- If gravelly—keep as it is; add nothing.
- If clay—discard; make new soil to order; or try one of the new soil conditioners.
- In general, do not add lime:
  - Plants that thrive with lime can do without it.
  - Plants that are averse to lime cannot tolerate it at all.

Roche

Some rock plants grow better and live longer in wall gardens than in other situations.

WALL GARDENS

Victor H. Ries

How to build walls of different sizes; size, shape, and kind of rocks to use; soil, drainage, and planting

WALL gardens are among the most practical and useful forms of rock gardens. They are easy and relatively quick to construct; they are easy to maintain and amazingly permanent. A properly constructed rock wall should last twenty-five to fifty years or more without needing to be rebuilt.

Since wall gardens are built without mortar or cement, they are often called dry walls and are really nothing more than specially constructed dry walls. Depending on their location and purpose, they may consist of anything from a single row of horizontally laid rock but a few inches in height to an extensive wall which may be 3, 4, or even 5 feet in height. They are built without any of the frost-proof foundation usually required for masonry walls. Low walls up to about 2 feet in height can be built directly on the ground. For taller walls, it is desirable to place a layer of fairly large rocks just beneath the surface of the ground, as a precaution.

Construction

Slope. The fundamental principles of building a wall garden are simple and relatively few. The individual pieces of rock must slope slightly downward toward the back of the wall. A difference in level of ¼ to ½ inch between the front and the back of a rock is ample. This is to prevent the rocks from slipping out of the wall from frost action, and to direct the flow of rain water into the wall, where the roots of the plants will be. The face of the wall is usually built to slope backward as it increases in height. A wall 12 inches high would have the top layer of stones approximately an inch back from the face of the lower level. This proportion should continue (the face set back roughly an inch to a foot) to whatever height the wall is built.

The size of the rocks is important. For small walls, up to 1 or 2 feet in height the individual pieces of rock should be not less than approximately 10 or 12 inches in length and width. For higher walls, the size of the rock should be increased for greater stability and permanence. A wall about 4 feet in height should be built of rocks at least 18 by 18 inches. This is a more or less arbitrary set of figures but gives some idea as to the size to use. The thickness of the rocks depends upon the taste of the individual constructing the wall. In general, and especially for smaller walls, rocks from 1 to 3 inches thick make a more interesting wall than blocks 6 to 8 inches or more in thickness.

The kind of rock used depends largely upon what is available. Usually limestone, slate, shale, or sandstone is used. In localities where none of these can be obtained, glacial boulders may be used; these are much more difficult to work into a wall and more likely to encourage the growth of weeds and grasses. When using glacial boulders, it is usually necessary to use a mixture of large and small rocks in order to get stability and permanence.

Laying the rocks. In building a low wall, the first layer of rocks is laid directly on the surface of the ground. If the wall is built on a slope, each layer of rocks should be more or less horizontal.

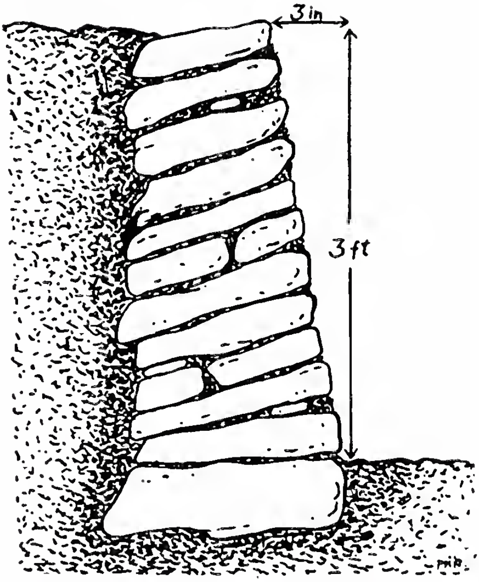


Diagram of wall, showing the proper slope of the individual rocks and of the face of the wall.

Ries

A low sloping wall such as this one is suitable along a driveway.

Sifted garden soil is placed over the top of this first layer of rocks, just as mortar would be in a masonry wall. The second layer of rocks is laid so that their joints do not coincide with those of the layer below. This process is repeated until the desired height is reached. Usually, every effort is made to have each layer of rocks relatively even and horizontal. The spaces between should be large enough to insert plants, but not so large that the soil is likely to wash out with heavy rains.

As each layer of rocks is put into the wall, the soil between it and the bank should be well tamped. If the soil is not firm, then as it settles, the wall will slide into the bank and have to be rebuilt.

Good drainage is important, for excessively wet soils may cause the rocks to slip. Banks or hillsides that are poorly drained or have seepage from springs should be tiled with lines of agricultural drain tile before the wall is constructed. One line of tile should be put just back of the wall and 6 to 12 inches lower, to drain the ground just beneath the wall. A second line of tile should be put on the hillside above the wall at a depth of 1½ to 2 feet, to catch the excess water and carry it away to a lower level. For walls that are already built, in which seepage is a problem, a line of tile can be put in the ground in front of the wall at a depth of 12 to 18 inches, to drain that area.

Ries

This interesting wall of flat stones is solidly laid with hidden mortar. Plants can overhang such a wall but cannot grow in its recesses.

Soil. If the wall garden is to be used for growing rock plants, it is well to prepare a special soil for use directly back of the wall and between the rocks, rathe than using the existing soil. If the soi present is clay, it may be mixed wit equal parts of sand and peat; if it is a fairly friable garden loam, half this amount of sand and peat may be used If there is to be a bed for rock plants above and back of the wall, this shoul be prepared with the same soil mixtur to a depth of 10 to 12 inches; the widt of the bed may be anywhere from 1 to 4 feet.

Planting

Planting the wall is relatively easy Many people prefer to plant as the wal is built; but this is practical only if a experienced person is constructing th wall. An inexperienced person is ver likely to damage the plants in the lowe part of the wall by putting his knees o rocks against them in building the uppe part. If adequate spaces are left between the pieces of rock, the averag rock plant can be slipped into this opening without too much difficulty.

The kinds of plants used and the typ of planting may vary tremendously. On should take advantage of the many possibilities the wall garden offers, and gro at least some of those plants that are difficult to grow in ordinary beds or in average rock gardens. Because of the better drainage in the wall, plants are les likely to rot, and one can often gro plants many years longer in the wall than in other locations. Although wall gardens are often planted with spreading types of plants, such as many of the stonecrops, creeping phlox, and thyme, such a planting does not take full advantage of the opportunities offered by the rock wall. Plants that spread by underground runners or have the ability to send stems for considerable distances between the rocks, such as Japanese spurge (*Pachysandra*), periwinkle (*Vinca*), and English ivy (*Hedera*), soon make pests of themselves and are extremely difficult to eradicate without taking the wall apart.

Plants for Wall Gardens

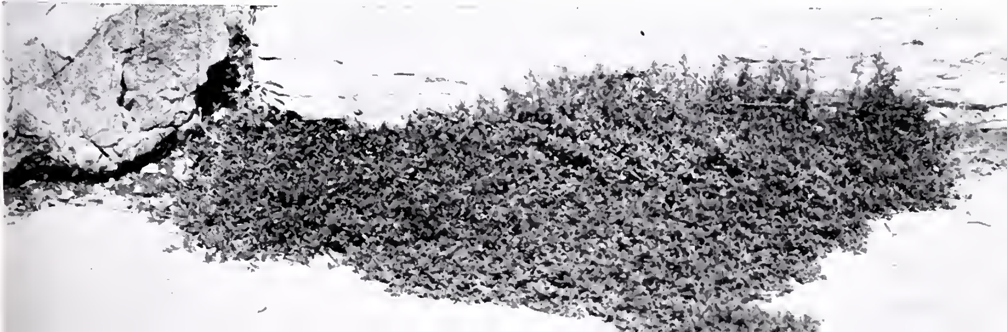
These are but a few of the many kinds of plants that are suitable for wall gardens. Most of them bloom in May in temperate climates.

White Flowers

mountain rock-cress, *Arabis alpina*
rock-cress, *Arabis procurrens*
mountain sandwort, *Arenaria montana*
tufted sandwort, *Arenaria verna*
Mt. Washington dryad, *Dryas octopetala*
mouse-ear gypsophila, *Gypsophila cerastioides*
creeping gypsophila, *Gypsophila repens*
edging (or evergreen) candytuft, *Iberis sempervirens*
Aizoon saxifrage, *Saxifraga aizoon*
(mossy) saxifrage, *Saxifraga decipiens*
strawberry-geranium (or strawberry saxifrage) *Saxifraga sarmentosa*
white stonecrop, *Sedum album*
leafy stonecrop, *Sedum dasyphyllum*
stonecrop, *Sedum nevi*
alpine catchfly, *Silene alpestris*
white mother-of-thyme, *Thymus serpyllum albus*

McFarland

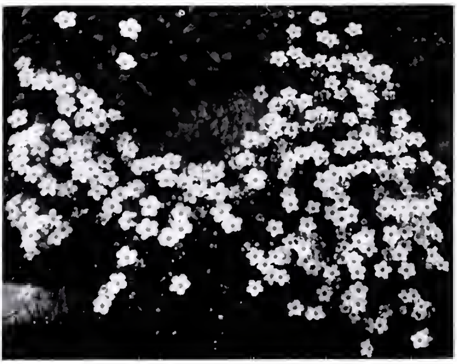
A wall garden in May.



Mother-of-thyme (*Thymus serpyllum*), while not an ideal wall garden plant, forms a dense mat in crevices.

McFarland

McFarland
The small crimson blossoms of *Thymus serpyllum coccineus* add to its attractiveness.



McFarland
Mountain sandwort (*Arenaria montana*) grows to a height of 4 inches and has white flowers.

Yellow or Orange Flowers

woolly yarrow, *Achillea tomentosa*
dwarf golden-tuft, *Alyssum saxatile compactum*
avens, *Geum borisi*
sun-rose, *Helianthemum*
St. Johnswort, *Hypericum coris*
creeping St. Johnswort, *Hypericum repens*
tufted evening-primrose, *Oenothera caespitosa*
Ozark sundrop, *Oenothera missouriensis*
alpine poppy, *Papaver alpinum*
three-toothed (or wine-leaf) cinquefoil *Potentilla tridentata*
dwarf spring cinquefoil, *Potentilla vern nana*
stonecrop, *Sedum ellacombianum*

McFarlan
Cheddar pink (*Dianthus gratianopolitanus*); its fragrant rose-colored flowers are an asse in many wall plantings.

orange stonecrop, *Sedum kamtschaticum*
Middendorf stonecrop, *Sedum middendorffianum*
Jenny stonecrop, *Sedum reflexum*
stonecrop, *Sedum rupestre*

Blue or Purple Flowers

alpine columbine, *Aquilegia alpina*
common aubrieta, *Aubrieta deltoidea*
tussock (or Carpathian) bellflower, *Campanula carpatica*
bellflower, *Campanula elatines garganica*
Dalmatian bellflower, *Campanula portenschlagiana*
true lavender, *Lavandula officinalis*
alpine toadflax, *Linaria alpina*
Persian nepeta, *Nepeta mussini*
cliff beard-tongue, *Penstemon rupicola*
creeping polemonium, *Polemonium reptans*
alpine savory, *Satureja alpina*
comb speedwell, *Veronica pectinata*
Hungarian speedwell, *Veronica latifolia*, or *rupestris*
horned violet, *Viola cornuta*
birds-foot violet, *Viola pedata*

Pink or Red Flowers

stone-cress, *Aethionema persicum*
rock-jasmine, *Androsace*
alpine pink, *Dianthus alpinus*
Auvergne pink, *Dianthus arvernensis*
Cheddar pink, *Dianthus gratianopolitanus*, or *caesius*
glacier pink, *Dianthus neglectus*
cottage (or grass) pink, *Dianthus plumarius*
liver-balsam, *Erinus alpinus*
heronsbill, *Erodium chamaedryoides*
dwarf blood-red geranium, *Geranium sanguineum prostratum*, or *lancastriense*
Columbia lewisia, *Lewisia columbiana*
Howell lewisia, *Lewisia howelli*
Tweedy lewisia, *Lewisia tweedyi*
phlox, *Phlox procumbens*, or *amoena*
moss-pink, *Phlox subulata frondosa* VIVID
Julia primrose, *Primula juliae* WANDA
rock soapwort, *Saponaria ocymoides*
Siebold stonecrop, *Sedum sieboldi*
houseleek (or hens-and-chickens) *Sempervivum*
moss campion, *Silene schafta*
crimson mother-of-thyme, *Thymus serpyllum coccineus*
tunic-flower, *Tunica saxifraga*

McFarland

Stonecrop (*Sedum ellacombianum*) grows about 6 inches tall and has yellow leaves and bright yellow flowers.

McFarland

Wall rock-cress (*Arabis albida*)

ROCK PLANTS FOR BEGINNERS—AND FOR OTHERS

Twenty-five very easy ones, and thirty-five more difficult but well worth the extra care

Stephen F. Hamblin

OUT of the thousands of small plants suitable for planting in a rock garden it is not easy to list a mere twenty-five that are the very best. These "best" plants should, of course, be available from some of the dealers and should not be thrown out of this list because they are everywhere seen. Personal preference must not be allowed to influence the choice; for if a plant is easily grown, withstanding heat of summer and periods of drought, and if it has some charm of flower or habit, it may be added to this list of the best. A dozen such lists could be made. The plants are listed here by date of bloom, from the time of the first snowdrop to severe frost of autumn.

Easy to Grow

Draba aizoon is one of the smallest of plants, blooming while still the ground is frozen. It is a tiny rosette of narrow pointed leaves, enlarging very slowly. On stems but 1 or 2 inches high there are clusters of small four-petaled flowers like those of mustard. The plant will grow in a crack in a ledge, as a small houseleek (*Sempervivum*) would.

Moss-pink (*Phlox subulata*) must be in every rock garden; the named seedlings are best, from pure white to pale blue, or *P. subulata brittoni,* a very dwarf variety with petals white or rose, deeply split. Sand phlox, or tenpoint phlox (*P. bifida*) is daintier; the plant roots but little, the leaves are not harsh to touch, and the five petals (white, lavender, or pale blue) are each deeply cut; there are no magenta colors in this group.

Madwort (*Alyssum*) provides yellow color to go with phlox. Really dwarf is the creeping madwort (*A. repens*); but it

Vernal iris (*Iris verna*)

McFarland

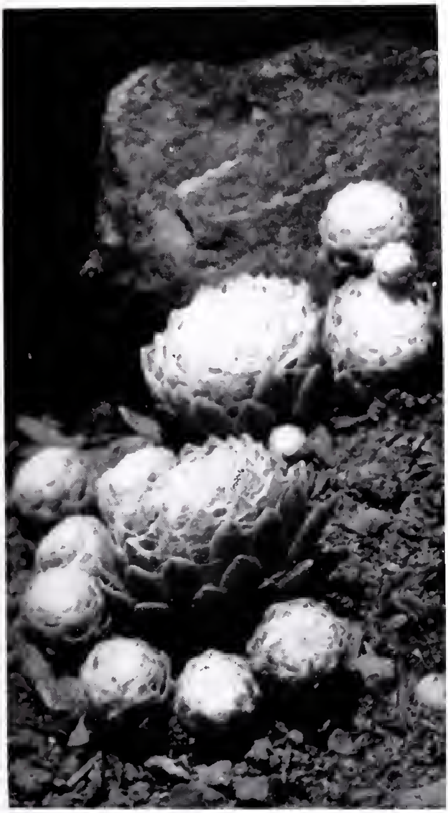
Thrift (*Armeria*)

is commonly not available. Limited quantities of golden-tuft (*A. saxatile*) are good, particularly in its pale yellow form, *A. saxatile luteum*.

Rock-cress (*Arabis*) may be used if phlox does not please: for white, *A. procurrens* or *A. sturi* (if available), or the common wall rock-cress (*A. albida*); for pink, some of the named forms of *A. albida;* for pale lavender, *A. aubrietioides*.

The shrubby candytufts also provide white; most of them are varieties of the edging candytuft (*Iberis sempervirens*), though other species are in cultivation. For really dwarf plants the more compact named seedlings, such as SNOWFLAKE and LITTLE GEM, are best.

Dwarf irises should be included. First on the list is the vernal iris (*Iris verna*), a large lavender flower resembling a crocus, in early May above dwarf iris foliage. The crested iris (*I. cristata*) walks about too much, so I choose its Japanese sister, the slender iris (*I. gracilipes*), with clustered lavender (or white) butterflies in late May.



McFarland

Cobweb houseleek (*Sempervivum arachnoideum*)

McFarland

Dwarf form of Hungarian speedwell (*Veronica rupestris*)

Pinks (*Dianthus*) are troublesome, for most seedlings become tall and spindling. The cottage pink (*D. plumarius*) is a perfectly good plant but too robust for a small rock garden. The named dwarf sorts, such as Sammy, Little Joe, and Tiny Rubies, are better. If only Cheddar pink (*D. gratianopolitanus*) could be obtained true to name!

Saxifrages—most of them—require a bit of attention in a dry rock garden; but *Saxifraga aizoon* survives the long heat of summer while its roots go deep into a crevice. This plant forms an evergreen rosette of stiff leathery leaves and 1-foot clusters of white flowers in June. Many are the species in the group closely related to *S. aizoon;* and *S. aizoon* itself has many variations among its varieties, even to flowers rose or yellow.

Thrift (*Armeria*) forms matted evergreen rosettes. The common thrift is *A. maritima,* in rose or white, or even red in *A. maritima laucheana.* There is heavy bloom in June, and scattered flowering through summer and again in the cool of autumn. The Pyrenees thrift (*A. juniperifolia*) is very dwarf (2 to 3 inches). Many species of *Armeria* are tall (2 to 3 feet) and too coarse for a small rock garden.

Beard-tongues (*Penstemon*)—the dwarf evergreen ones — are truly shrubs, and many of the herbaceous species are too tall for most rock gardens. Many species are difficult of culture and not very long-lived. For ease of culture, the native eastern species *P. hirsutus* is good; the flowers are pinkish lavender.

Wild pink (*Silene caroliniana*) is the best of the many catchflys and campions for a beginner. It is native to open fields of the eastern states. Great masses of the rosy pink flowers of this plant adorn our rocky fields as soon as moss-pink has faded. Wild pink seeds itself readily, but the mother plants may be short-lived.

Allium is a group of summer-blooming bulbs. Even chives (*A. schoenoprasum*) might be planted in moderation. The many species of the Rockies are not now available. For clear yellow flowers the best is *A. flavum,* scarcely a foot tall.

Cinquefoils (*Potentilla*) are offered in large numbers, some tall and weedy, others dwarf and really showy of flower, white or yellow. One of the best is *P. megalantha* from Japan; the plant is somewhat like a young strawberry plant: each leaf has three broad leaflets; but it has very large deep yellow flowers in June, the eye of the flower orange.

Yarrow (*Achillea*) includes tiny alpines and giant coarse weeds. For our list we

Pasque-flower (*Anemone pulsatilla*)

McFarland

egin with the woolly yarrow (*A. tomen-osa*), a dwarf with flat clusters of yellow eads in June. There are other dwarf spe-ies with flowers white.

Of **houseleeks** (*Sempervivum*) there re at least twenty-five distinct species nd hybrids all hardy and easy to grow. Of first interest is cobweb houseleek (*S. arachnoideum*), though it rarely blooms; the rosettes have a white "spider web" of threads across the center. This plant will live in any heat, with almost no soil, merely in a crack in a ledge. The many hybrids also have the webbed threads to some degree; any webby houseleek can be depended on to be dwarf and permanent.

Tunic-flower (*Tunica saxifraga*), a little plant in the pink family, is like a slender babys-breath. Though its roots are not deep, it withstands heat and drought and blooms profusely with tiny white or pink flowers from June to frost. It is a slender wiry little plant, easily transplanted, and it seeds itself. There are double white and pink forms known, like a baby edition of the big BRISTOL FAIRY babys-breath. For ease of culture and mist of bloom it exceeds catchfly (*Silene*), campion (*Lychnis*), sandwort (*Arenaria*), and *Gypsophila*, all of which have dwarf and showy species.

Speedwell (*Veronica*) includes many tall plants and many small ones. In drought they often wilt badly. First choice is the woolly speedwell (*V. incana*), for blue-gray foliage in full sun. The bloom is the usual spires of tiny blue flowers. This plant varies greatly in height and in the blue of its foliage. For evergreen basal foliage first place goes to what is called *V. rupestris*—probably a form of Hungarian speedwell (*V. latifolia*); the short spires of flowers in June are blue, rose, or white.

Bellflowers (*Campanula*) must be represented, and many are the species small enough for the usual rock garden; but they may be short-lived, die in dry heat, or not survive rough winters. First on the list is the tussock bellflower (*C. carpatica*), with erect cups of blue, lavender, or white from July to frost. Some of the varieties are rather tall and flopping; but others, such as *C. carpatica nana* and *turbinata*, have a dwarf compact habit.

McFarland

Aubrieta

Thyme. All kinds are evergreen and really woody. The common mother-of-thyme (*Thymus serpyllum*) grows too willingly, and its seedlings come up all over the garden. The woolly thyme (*T. serpyllum lanuginosus*) almost never blooms, and so there are no seedlings; and white thyme (*T. serpyllum albus*) seems content to bear the many tiny white flowers and no seeds. Caraway thyme (*T. herba-barona*) has long slender wiry stems which drape themselves gracefully over the rocks, and does not spread by seed. It can easily be identified by the strong caraway odor.

Stonecrops (*Sedum*) must be in the easy rock garden; but many of them are far too easy of growth and not too showy of bloom. *S. sieboldi* is at the top of the list of desirable ones, since it forms a tight tuft and blooms in late August. The rounded wide fleshy leaves are in three's on the stem, blue-green in color. The flowers are pink, in close clusters.

Aster. In August and in the autumn there are many dwarf composites, still thriving in spite of heat and drought. Many are the dwarf asters, but those of the Old World require some summer rain. In dry fields of the eastern states, in September, blooms *Aster linariifolius*, on leafy stems of a foot or less, with leaves

McFarland

Stonecrop (*Sedum sieboldi*)

the shape of pine needles and terminal clusters of lavender (or white) little stars. It is easy to grow and showy, and blooms very late. Not all rock garden dealers offer it, but some of them do—also some of the dealers in native plants.

Arctic chrysanthemum (*C. arcticum*) comes last, with waxy rounded leaves, mostly basal in a mat. At flowering time the stems rise 3 to 5 inches, with white heads like the daisies of June. Since it grows above the Arctic Circle, this plant is hardy and permanent, if it gets a bit of rain in summer. Its hybrid ASTRID has larger flowers, the rays light lavender; but most of its hybrids are as tall as the usual border sorts.

More Difficult, but Choice

The chief thing that makes certain rock plants difficult to grow is lack of moisture in the summer season. Many plants supposedly winterkilled are actually "summer-killed," but their demise is not noted until the following spring. Many plants that are watered by natural seepage in their native home, must have an inch or so of rain at least twice a month in June, July, and August, at sea level; some of these are the easy-to-grow kinds of the great trio of the rock garden—gentians (*Gentiana*), primroses (*Primula*), and saxifrages (*Saxifraga*). The following are samples of choice plants that are not difficult if they are given water when they need it.

Among **gentians** for the rock garden the best are those dwarf sorts that bloom in April and May with flowers like big blue tubes. Such are the stemless gentian (*G. acaulis*) and its kin, and the smaller Bavarian gentian (*G. bavarica*). They are the best for good gardening in the spring, if kept moist through the following months.

The alpine anemones, such as the pasque-flower (*A. pulsatilla*) and the vernal anemone (*A. vernalis*), have flowers resembling crocuses, in April, above finely-cut foliage; after the flowers come the fuzzy seed heads. Purple, blue, lavender, pink, white, and even yellow, are the possible colors. Anyone who succeeds with these anemones may try other species.

Cinquefoils (*Potentilla*). Several of the small ones give flowers of gold in April and May, particularly *P. verna nana*. Other alpine species offer flowers of white.

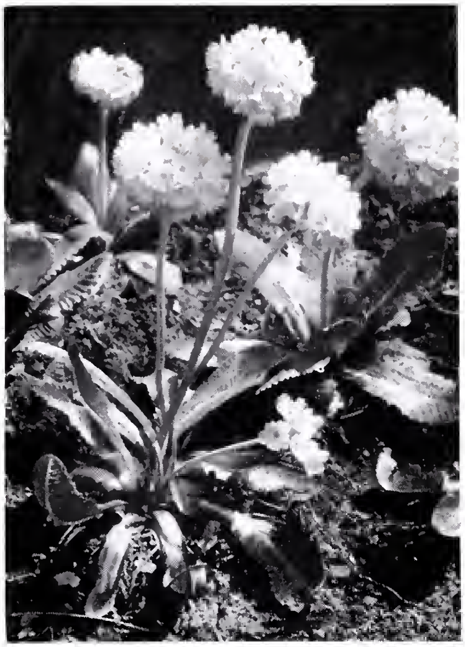
Tiny **buttercups** (*Ranunculus*) are also gold in May. "*Ranunculus*" means "little frog"; and like little frogs, certain kinds of buttercups must have constant moisture. Smallest and brightest is lesser celandine, or fig-root buttercup (*R ficaria*), spreading to sheets of shining little leaves and brilliant yellow bloom in soil permanently wet.

Aubrieta grows in a flat mat, with smal clusters of four-petaled, blue, purple rose, or red flowers in May. It is a member of the mustard family and reminds one of the yellow- and white-flowered *Arabis, Alyssum,* and *Iberis.* In some gardens it riots as madly as thyme; in others it is nearly a total failure. If too dry in summer, it withers away; too wet in winter, it is also a total loss. Yet it can give sheets of blue-purple color following moss-pink.

Rock-jasmines (*Androsace*) are cousin of the primroses and may be easier t grow in soils that are a bit dry. Some o them are little annuals; but *A. sarmentosa* has heads of pink flowers, resembling primroses, from mats of foliage; this and many other species of *Androsace* send out runners, as strawberry plants do.

Primroses usually have a tight clump of foliage like lettuce. The easiest and earliest kind is the Himalayan primrose (*Primula denticulata*), a round golf ball of rose or white teed up on a stem 2 to 4 inches tall. Auricula (*P. auricula*) will take some drought punishment; the leaves are very mealy, the clustered flowers yellow and odd dull colors. Better for small rock gardens than the English primrose is the smaller Julia primrose (*P. juliae*) from the Caucasus. The plant is dwarf; the small leaves shining green; the solitary flowers red, purple, or rose, and also yellow to white in its hybrids. For a crevice near water the Julia primrose is as showy as the rarest. Wrinkled foliage in clumps like lettuce, and heads of rose blossoms resembling phlox are found in the trio *P. cortusoides*, *P. sieboldi*, and the cliff primrose (*P. saxatilis*). They can be kept growing lustily after the bloom of May by added water in dry weather.

Creeping phlox (*P. stolonifera*) and its kin *P. procumbens* have round opposite leaves and leafy runners like those of strawberry. The rather large flowers, in rose, lavender, or nearly white, are in heads like primroses in May and June. The plants should be watered in August.



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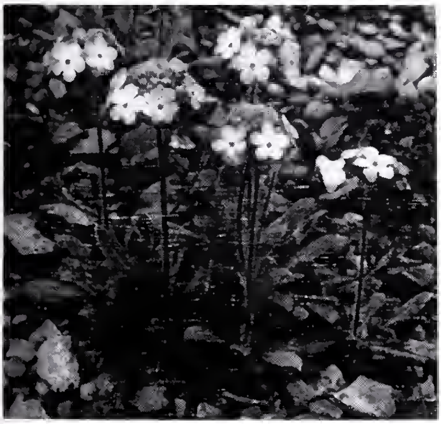
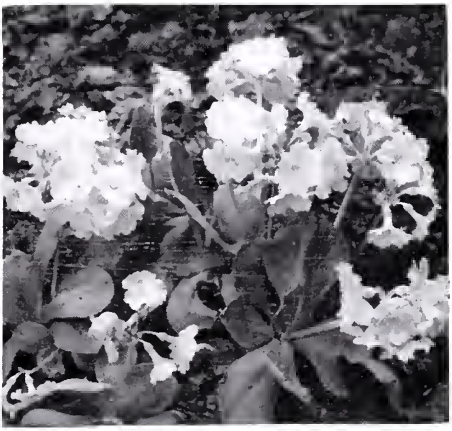
Himalayan primrose (*Primula denticulata*)

Columbines are generally not difficult to grow but are often short-lived and are usually not true to name when purchased. Most distinct is the fan columbine (*Aquilegia flabellata nana-alba*), pure white, a dwarf edition of the European columbine (*A. vulgaris*).



McFarland

Rock-jasmine (*Androsace sarmentosa*)



J. G. Bucher courtesy

Auricula (*Primula auricula*)

Stone-cress (*Aethionema*)

McFarland

Fan columbine (*Aquilegia flabellata nana-alba*)

Little Jap iris (*I. minuta*), with little yellow flowers, seems to be the smallest iris species. It is rare in nurseries, and so tiny of root system that a drought may soon kill it.

Stone-cress (*Aethionema*) is the most unusual of the mustard family. Some of the stone-cresses are little weedy annuals; others are evergreen shrublets with blue foliage and heads of pink flowers. Several species are listed, but best is the hybrid, *Warley Rose.*

The **rock aster** (*A. alpinus*) should give big lavender (to white) heads like daisies in June and July, but it is often not so permanent as the native species. All the Himalayan dwarf species, such as *A. farreri* and *A. himalaicus,* are similar and demand occasional summer rain.

Saxifraga is a large and varied genus The aizoon group may survive much summer neglect; but the mossy group and certain other groups must have a scree (page 212) or water from the hose in summer. The mossy types are particularly difficult, for they wither away in summer droughts, yet become decayed if too well watered.

Dryas is a woody plant in large mats with oblong evergreen leaves; it has flowers somewhat resembling those of strawberry, white or yellowish, but with a dozen or more petals, and not borne in clusters. It is native to Canada and Switzerland, where it grows willingly but in urban rock gardens it must have leaf mold truly moist.

Onosma is the "donkey's smell"; it has a rosette of hairy evergreen leaves and is quite unlike forget-me-nots, which belong to the same family. In May and June it has large drooping bells of yellow (or pink to white). While it grows willingly at the start, it seems to pine for its native region around the Mediterranean.

The **star astilbe** (*A. simplicifolia*) and a Japanese **meadow-rue** (*Thalictrum kiusianum*) are but a few inches high; they bloom in the summer, but only when well watered.

Cranesbills (species of *Geranium*). Most of these are too large for a small area. Perhaps best is the blood-red cranesbill (*G. sanguineum*), with its white variety (*G. sanguineum album*) and the dwarf Lancaster form (*G. sanguineum prostratum*).

Heronsbill (*Erodium*), in the same family as the cranesbills, is usually dwarfer; good species are *E. macradenum* and *E. chamaedryoides*.

Campanula adds a fourth to the alpine trio (*Primula*, *Saxifraga*, and *Gentiana*); many of the bellflowers bloom in June and July and thus carry spring into summer. Perhaps worthiest at the start are *C. elatines garganica* and the Dalmatian bellflower (*C. portenschlagiana*). For one who can grow these successfully the list is endless.

Pinks. Many small species are showy but not too easy to grow. The alpine pink (*Dianthus alpinus*) is particularly desirable, a tiny tufted plant with pure green leaves and outsize flowers of rose (or white). It must have a scree (page 212) or frequent summer showers, or back it goes to its native Alps. The zoned pink (*D. callizonus*), *D. noeanus*, and *D. spiculifolius* are all choice and usually easy to grow under scree conditions.

The **globe-daisy** (*Globularia*) is unusual in its round heads of metallic blue. The prostrate globe-daisy (*G. repens*) is the smallest and is so tiny that it is often forgotten in droughts. The heart-leaf globe-daisy (*G. cordifolia*) is the one most commonly seen.

The **Spanish stonecrop**, or mealy-mat (*Sedum hispanicum*) is the smallest stonecrop. It forms a mat of fleshy blue-green leaves scarcely an inch high. It has so little bulk of stem or root that it is easily killed in dry seasons.

Cyclamen. Some of the hardy species are the last of the choice rock plants to bloom. *C. neapolitanum* is especially good—a tiny relative of the big species of the florists. The nodding rose (or white) flowers appear from the bare earth in late autumn. This plant needs moist leaf mold and some shade; its flowering marks the end of the rock garden season.

McFarland

Rock aster (*Aster alpinus*)

McFarland

The cactus called prickly-pear (*Opuntia vulgaris*).

ROCK GARDEN CLINIC

Answers to a few of the many questions asked by those having rock gardens and by prospective rock gardeners

Victor H. Ries

Planning and Location

WHAT is the best time to start a rock garden?

Construction may be started any day of the year. Planting is best done either in spring or in early fall.

Isn't the interest in rock gardens likely to be temporary?

Millions have had rock gardens and rock walls for years and still enjoy them; but anyone who wishes to have one just because he thinks it is going to be fashionable would do best to avoid one. It is very difficult to get rid of the rocks when one is tired of them.

What exposure is most satisfactory for a rock garden?

This depends on the local climate and on the types of plants grown. In the regions with cooler summers, east, south, or west exposures are perfectly satisfactory. In the regions with warmer summers, including the Midwest, an east exposure or even a north exposure is preferable. The sun-baked south and west exposures may be used if they can be shaded by trees sufficiently far away to keep their roots from interfering with the plants in the rock garden.

Is it wise to plant a tree near a rock garden for partial shade?

In some sections of the country, such as the South and the Midwest, some summer shade may be advisable; but if a tree is planted near by, the roots may become more of a problem than the sun. It may be better to avoid excessive heat by changing the site of the rock garden so that it will not get the direct south or west rays of the sun. Sometimes the shade of a large rock is sufficient to protect some of the smaller alpine plants.

Isn't a rock garden the ideal solution

for shady spots where it is difficult to grow ordinary plants?

No—unless the rock garden is to contain only wild flowers. The majority of the ordinary rock plants and alpine plants require at least half a day of sun. Shady spots may be planted with ground cover plants, such as English ivy (*Hedera helix*), periwinkle (*Vinca*), or one of the evergreen wintercreepers (*Euonymus fortunei*).

Is it practical to put a rock garden in a very hot and dry location where the average garden flower will not grow?

Only if one is willing to use nothing but the more iron-clad plants that can survive such conditions. These include prickly-pear—a cactus—(*Opuntia*), some of the stonecrops (*Sedum*), most houseleeks (*Sempervivum*), *Lewisia*, and other plants that grow naturally in hot and dry locations.

Design and Construction

How high should a rock garden be?

If it is on a bank, no higher than the bank, naturally. In any case, not so high that the gardener cannot reach the various parts. In high gardens, walks are sometimes made at intervals, to allow easy access. On level ground, any rock garden should be as low and rambling as possible, usually with an elevation of not more than 1 to 2 feet above the surrounding ground.

Is a pool necessary in a rock garden?

No. This is entirely a matter of personal choice. Many otherwise attractive rock gardens have been spoiled by the introduction of an artificial-appearing pool. Usually, any water, whether in the form of a stream or a pool, should be as naturalistic as possible.

What portion of the rock garden should be exposed rock?

Just as in other forms of art, it is difficult to express this in figures. Different writers have expressed the opinion that from one third to two thirds of the rock garden should be the rock itself, with plants and the soil surface making up the rest of the picture.

How much of each piece of rock should be exposed to view?

That is difficult to say because of the variation in construction of the different types of rock gardens. In general, enough of the rocks should be buried to give stability and permanence. This may be from 10 per cent to 50 per cent of each one.

How small may the rocks in a rock garden be?

This depends upon the size of the rock garden; but even in the smallest rock garden the smallest rock should be large enough to stand on. Then one can get around in the garden without stepping on the plants. The rocks should weigh not less than about 25 pounds and should be at least 3 or 4 inches thick. These are purely arbitrary figures but should furnish a starting point.

How large may the rocks be?

In a small garden, about 10 to 20 feet long and a few feet wide — from 25

Petticoat daffodil (*Narcissus bulbocodium*), with angels-tears (*N. triandrus*) in background. *McFarland*

Ries

The Persian tulip (*Tulipa patens*) is often listed in catalogs as *T. persica*. It is a dainty little thing that can be used in even the smallest rock garden.

pounds to 300 or 400 pounds. As the garden increases in size, the largest rocks may increase in size and weight up to the limit that can be handled by the equipment available. In general, a variation in size is more interesting than uniformity.

Is it not more interesting to have a variety of rocks from different places, rather than just one kind?

A variety of rocks looks like a geological collection and may be used alone without plants. Using but one kind of rock, and using it as naturally as possible, gives the most artistic effect in a rock garden.

What kinds of rocks are preferable?

First of all, weathered rocks, if possible. The softer types of rock, such as limestone and sandstone, usually make more interesting gardens than the harder granites and glacial boulders.

Are the slabs from broken concrete walks and drives satisfactory?

Sometimes rather interesting effects are obtained with them; but they have an extremely artificial appearance unless they are almost completely covered with plants.

Are broken flagstone walks satisfactory for walls?

Perfectly. In some localities, the easiest way to make a wall garden is to secure the old flagstones that someone is replacing with concrete.

What is a moraine garden?

In alpine areas, the pile of rock and soil that is pushed up by a glacier, either along its sides or at its end, is called a moraine. The pile of material usually has water running beneath it. This condition is sometimes reproduced on a miniature scale and is called a moraine garden. A foot or so beneath the surface, water runs through crushed stone or gravel. Alpine plants that would otherwise be difficult can often be grown under these conditions.

What is a scree?

It is similar to a moraine garden, except that there is no running water beneath. It is usually a pocket or even a pile or ridge made up of sand, crushed rock, and peat moss, with a little soil. It has perfect drainage, perfect aeration. Many otherwise difficult plants can be grown in such a garden.

What is an alpine meadow?

Essentially a rock garden without rocks: a miniature of what is found in rockless level areas in the mountains, with low-growing plants growing close together in a more or less solid turf. This is a good place to put spreading types.

Soils, Fertilizers, and Water

How deep should the soil be prepared?

At least a foot—between the rocks.

Can regular garden soil be used in th rock garden?

It depends upon what plants are to b grown there. For most of the plant grown, any good garden loam is satisfactory. Many of the true alpine plants require perfect drainage supplied by a soi mixture made up of approximately equa parts of soil, sand, and peat.

If the rock garden or wall garden is a the base of a slope, how can one contro the water that comes down over the surface?

Make a shallow trench just above th wall or rock garden, to catch the wate and carry it away.

In a hillside rock garden, how can on prevent washing and erosion?

By leveling the little pockets of soil between the rocks and by the use of creeping plants for the areas most likely to wash. Such plants as thyme and creeping phlox are highly satisfactory. The use of stone chips on the surface also tends to reduce the washing.

Why are stone chips used on the surface in some rock gardens?

Some of the alpine plants are inclined to rot in ordinary soil; stone chips hold the crown above the moist soil and help to prevent rotting.

Should a rock garden be cultivated?

No. If the surface is mulched with rock chips for alpines, and with peat moss or similar material for other plants, there is no need for cultivation.

Should a rock garden be fertilized?

The average rock plant, which is merely a low-growing hardy flower, responds well to fertilization. Some of the true alpines, which are likely to be difficult to grow, particularly in some climates, are better off without fertilizer, or with very little. Fertilizers tend to encourage soft succulent growth, which makes the plants more difficult to keep.

Is it better to use a natural fertilizer, such as bone meal or sheep manure, rather than a commercial fertilizer?

There is absolutely no reason why commercial fertilizers cannot be used; once the material is in soluble form in the soil, the plants cannot distinguish the source of the original fertilizer. Besides, with commercial fertilizers, we know exactly what we are putting on—which is not always true of some of the natural fertilizers.

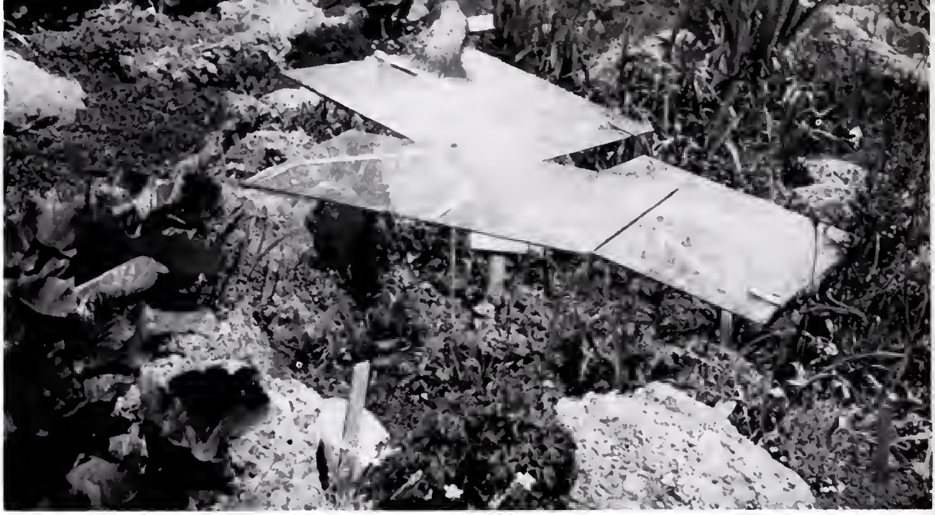
What should the reaction of the soil be —acid, neutral, or alkaline?

Although some of the literature states that limestone and alkaline soils are detrimental to most rock plants, this can be questioned. Except for those plants that definitely require an acid soil, the proper texture—to allow for adequate aeration and drainage—is probably of far greater importance than the reaction of the soil itself.

Doesn't the reaction of the soil change considerably from too much or too little watering?

Contrary to popular belief—no. It is the addition of lime that tends to make the soil more alkaline. Such fertilizers as cottonseed meal, soybean meal, and ammonium sulfate tend to make the soil acid, but it is doubtful if sufficient quantities of them would ever be applied to affect the reaction of the rock garden soil.

Narcissus minimus, an early-blooming daffodil only 3 to 6 inches tall. *McFarland*



Kies

Alpines that are inclined to rot in winter or early spring can often be saved by being kept dry with plates of glass or plastic.

What plants normally require an acid soil?

About the only ones we can be sure of are the various members of the heath family, such as rhododendrons, azaleas, heathers.

How can one determine the best soil reaction for any particular plant?

There is no satisfactory method. The basis for many of the statements that certain plants require this or that soil reaction is the soil in which they grow wild. In most cases, mountain soils naturally have an acid reaction. This does not mean, however, that the plants found there cannot grow just as well in a soil with a less acid reaction, that is, a neutral or slightly alkaline one.

General Care

How often should a rock garden need to be done over?

A rock garden does not differ very much from a hardy flower border. After three years, many of the plants need to be divided and replanted and many of the smaller bulbs replaced.

Does not a rock garden need less care than other kinds of gardens?

All too many gardeners have been misled into believing that a rock garden does not require care. The average rock garden (except a wall garden) requires more or less constant attention to prevent weeds from becoming established and crowding out the other plants. Also, since many rock plants spread rapidly, a few may take over the garden and crowd out the rest, if they are not restrained.

What rock plants require winter protection?

That depends upon the locality. In general, most of them live over winter without protection if drainage is adequate. Some can be protected by a bit of excelsior or fibre glass wool. Some of the more difficult plants may require being kept dry over winter by use of a pane of glass or some plastic material. Since most rock plants have evergreen foliage, heavy mulches are more likely to cause damage than to help. Shading reduces the amount of heaving caused by frequent freezing and thawing.

Plants—General

What are the possible choices of plant material for use in rock gardens?

Very dwarf shrubs or trees, alpine plants, and other low-growing or slow-growing annuals and perennials. Alpine plants are plants that grow naturally in mountainous regions at elevations of about 4,000 to 11,000 or 12,000 feet, where plants have to be more or less dwarf to survive. Alpine plants are the true, or original, rock garden plants; but many other kinds of plants are also suitable for rock gardens.

How many different kinds of plants should one use?

For the minimum variety of bloom and foliage interest, one might use from a dozen to twenty. A collector might easily have 100 or even 200 different kinds.

How large should the different groups or colonies of each kind of plant be?

This depends upon the size of the garden and the number of different kinds of plants. In a very small garden, there may be only one to three plants of a kind; in a larger garden, from a dozen to fifty individuals may make up a colony. In a garden with many different kinds of plants, there will necessarily be smaller groups of each; for landscape effect, relatively large groups are better.

How tall may plants be in a rock garden?

This depends entirely on the size of the rock garden. If it is only 10 to 20 feet long and a few feet wide, it should not have any plant over 6 or 8 inches tall, except as a background planting. In a very large rock garden much taller plants may be used. In general, the smaller the rock garden and the smaller the plant in stature, the more enjoyable the garden will be.

Is it better to grow one's own plants from seed or to buy plants?

Those who have facilities for growing their own plants from seed find great fascination in doing so; but many plants must be bought as plants, either because they do not come true from seed or because the seed is not available.

What book can be used to identify rock plants?

There is no one satisfactory book; rock plants come from a wide range of geographical areas; books on wild plants deal with limited areas; and the horticultural manuals contain only the commoner rock plants.

Are not native American plants better than European or Asiatic plants?

Not necessarily. Plants from other continents sometimes do better in our gardens than plants from other parts of America.

Where in North America can native alpine plants be found?

There are some very interesting ones in the White Mountains on the higher peaks, and on the peaks of the Great Smoky Mountains; but the majority of them are found in our western mountains. In the East, the elevation at which they are usually found is from about 4,000 feet up. In the western mountains, they are more likely to start at an elevation of 7,000 or 8,000 feet. The Canadian Rockies and Selkirks, the Rocky Mountains in Colorado, the Sierras, Mt. Rainier, the mountains of the Olympic Peninsula, the Wenatchee Mountains, and the Snowy Mountains of Wyoming are but a few of the places one should plan to visit.

Kinds of Plants

What are some interesting special groups to plant in a rock garden?

Some of the larger genera that are interesting to try are *Dianthus*, *Campanula*, *Iberis*, *Primula*, *Sedum*, *Sempervivum*, *Alyssum*, *Veronica*, *Hypericum*, *Arenaria*, and *Penstemon*.

Are Christmas-roses (Helleborus niger) suitable?

Very much so, for they are relatively dwarf in stature and evergreen, bloom in late fall and winter, and grow slowly enough to avoid crowding out other plants. A sister plant, the Lenten-rose (*Helleborus orientalis*), is equally desirable, though slightly larger and faster-growing.

Would you recommend roses?

The dwarf roses, such as the fairy (or

Blue fescue (*Festuca ovina glauca*), an ornamental grass that grows only about 2 feet tall. McFarland

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Christmas-rose (*Helleborus niger*).

McFarland

Cut-leaf peony (*Paeonia tenuifolia*).

pygmy) rose (*Rosa chinensis minima*) and its varieties and hybrids, can be used very effectively even in the smallest rock garden. Most of the polyanthas, hybrid teas, and others are too large for all except the very largest rock garden.

Can tulips be used?

The difficulty with most tulips is that after they are through blooming, their coarse foliage is unsightly for a period of some weeks. However, many of the species tulips are sufficiently dwarf to be used to advantage.

Can daffodils be used?

The finer-leaved and smaller-flowered daffodils may be used—the species and some of the smaller hybrids.

Can irises be used?

Yes, the low-growing ones, such as varieties of the dwarf iris (*Iris pumila*), the netted iris (*Iris reticulata*), the crested iris (*Iris cristata*), and the Japanese roof iris (*Iris tectorum*). Most of the other irises are too tall for the rock garden.

Can peonies be used?

Except possibly for the very early cut-leaf (or fern-leaf) peony (*Paeonia tenuifolia*), they are too large and coarse to consider.

Can ferns be used?

Yes. Some ferns are suitable for a sunny rock garden, others for a shaded one. Certain ferns are undesirable because they become invaders; and some, such as the ostrich fern, are entirely too large for a rock garden.

Can ornamental grasses be used?

Most of the ornamental grasses are too tall to be used satisfactorily. One lovely little grass (difficult to locate in nurseries, however) is blue fescue (*Festuca ovina glauca*). Occasionally some of the native sedges may be used.

Undesirable Plants

Would you recommend patches of Japanese spurge (Pachysandra), periwinkle (Vinca), and English ivy (Hedera helix) in the rock garden to give winter effect?

No. All three of these plants spread rather rapidly and would soon crowd out all the other plants.

How can one predict which plants are likely to become pests and which are good rock garden plants?

Plants that spread by runners on the surface of the ground or just below it have been the downfall of all too many beginners in rock gardening. Nurseries and well-meaning friends often recommend plants that tend to take over the rock garden and smother other plants.

Is it possible to use a weed killer in a rock garden?

Not if it is planted with rock plants. There is still no substitute for the old-fashioned method of hand pulling; weeds should be taken out while they are young and easy to pull.

How can one get rid of the stringy stonecrop (Sedum sarmentosum)?

Unfortunately, this extremely weedy plant has been sold or given to all too many unsuspecting beginners. Pulling out every stem and every leaf, and looking carefully once a week to see that none have reappeared, should bring it under control by the end of one growing season; otherwise, it may take ten years.

How can grass be kept out of a rock garden?

The same as any other weed—by hand pulling; it must be pulled frequently enough to keep it from becoming established.

Roof iris (*Iris tectorum*), with rock soapwort (*Saponaria ocymoides*) in foreground.

NATIVE NORTHEASTERN PLANTS FOR THE SHADY ROCK GARDEN

For flowers from March to July and year-round beauty from evergreens: pleasing variety with eighteen flowering plants and eleven kinds of ferns

William C. Horsford

McFarland

Spring beauty (*Claytonia virginica*)

THROUGH hybridization and selection many new forms of our wild flowers have been produced, some of them lovelier than the originals. Still, the original wild flowers, known as natives, are most beautiful and graceful in the rock garden.

Why and How to Use Them

Transplanting. Wild plants are often overlooked when a rock garden is planned; many people are wary of them, in the mistaken belief that they will not grow outside of their natural setting. This belief has been built up because many persons have gone into the woods and dug their own plants without knowing the proper time to do it. Naturally, they have taken the plants when they could easily recognize them, often in late spring or in midsummer when the plants were in full flower. Plants moved at such a time almost always fail to grow.

Markers. Another cause of loss of plants is the failure to put permanent markers beside plants that flower early in the season and then lose their foliage; many such plants are destroyed in the process of weeding. *Dicentra, Claytonia, Anemone,* and *Sanguinaria* are often destroyed in this manner.

Soil. Some of the natives are very intolerant of changes of soil conditions but will thrive if the soil is made similar to that in which they grow wild. Adding peat moss, humus, or aluminum sulfate helps to create acid conditions; vermiculite or ground lime is good for alkaline requirements. This treatment should be repeated frequently.

Sunlight and moisture in the right amounts are important to wild plants. Yet many plants growing in moist, shady places have proved their ability to be moved into fairly dry, sunny gardens, and there even to surpass their natural habit in vigor and beauty. Lobelia, meadow-rue, snakeroot, and Jack-in-the-pulpit are among these. Nurserymen who grow native plants must give extensive consideration to these requirements and can be most helpful with advice on this point. This is one reason why all conservation societies recognize the nursery as the best source of native plants for gardens.

The program of conservation of wild flowers is aided when these plants are introduced into new gardens from nursery-grown stock. Many wild plants readily increase by means of seed, division, or underground stems.

Commercial fertilizers or manure should never be used on ferns or on most wild flowers. Natural conditions should always be simulated wherever this is possible. When surplus plants are evident, they should be passed on to another interested person, or exchanged for plants the owner desires.

Flowering Plants

For early spring, colonies of spring beauty (*Claytonia virginica*), Dutchmans-breeches (*Dicentra cucullaria*), and liverleaf (*Hepatica triloba*) find a place in any garden. The miniature bleeding-heart flowers of *Dicentra* are set off to advantage by its silvery green foliage. *Dicentra* and *Claytonia* soon disappear until the next spring, but *Hepatica* has attractive green leaves that turn a ruddy red to match the autumn foliage.

Roche

Bloodroot (*Sanguinaria canadensis*)

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Dutchmans-breeches (*Dicentra cucullaria*)

Early meadow-rue (*Thalictrum dioicum*), with its purple and white flowers and graceful foliage, is another favorite.

Bloodroot (*Sanguinaria canadensis*) and early saxifrage (*Saxifraga virginiensis*) are suitable for the rock garden, each with its distinct white flowers. Each bloodroot flower comes out of the ground rolled in a leaf, which accents the flower as it unrolls. Saxifrage shows to best advantage when planted in groups; the flower stalks lengthen daily while the plant is in bloom.

For May bloom, columbine (*Aquilegia canadensis*), the downy yellow violet (*Viola pubescens*), foam-flower (*Tiarella cordifolia*), bishops-cap (*Mitella diphylla*), and fringed polygala (*Polygala paucifolia*) may be used. Polygala, with its orchidlike pink flowers and evergreen leaves on trailing stems, is somewhat difficult to establish but well warrants the effort. Columbine, with its scarlet flowers, is at home in full sun or in shade; in its native state it often grows out of a mere slit in the rock, high on a ledge. Yellow violets fill in where small plants are needed, and readily adapt themselves to dry open situations. Foam-flower and bishops-cap are interesting subjects with pleasing foliage and graceful flowers. Foam-flower makes an excellent ground cover; and as in *Hepatica*, its leaves take on a bronzy red tone in the autumn.

A slightly moist spot is recommended to start with. If such a place is available, a few plants of Jack-in-the-pulpit (*Arisaema*) should be used. The flower and the cluster of red berries that follow (on the female plants) make a long-lasting addition to the garden.

Late in May and early in June a few stalks of yellow lady-slipper (*Cypripedium calceolus pubescens*) give the rare beauty of an orchid. Nature has provided this plant with the ability to grow in either dense swamp land or rocky uplands and side hills. Fortunately thousands of tiny dustlike seeds are annually spread by the winds, and new colonies will appear after several years if conditions are favorable.

Late June and July bring the harebell, sometimes called bluebells of Scotland (*Campanula rotundifolia*). The tiny clear blue bells on wiry, grasslike stems stand out when planted at the base of ledges or large rocks.

Herb-Robert (*Geranium robertianum*) soon establishes itself, although it is a biennial. Its lilac-pink flowers and fern-like foliage serve to cover spots that might otherwise remain bare. This plant also has pleasing autumn foliage, turning bright red, and often lasting through the winter months.

Fall and winter. Since many of the wild flowers that bloom in late summer or fall are too tall for rock gardens, or require moist situations, little is left except the evergreens such as wintergreen (*Gaultheria procumbens*) and partridge-berry (*Mitchella repens*). Their flowers are minute; but the red, edible fruits serve a greater purpose. Wintergreen prefers a slightly acid sandy soil, growing in

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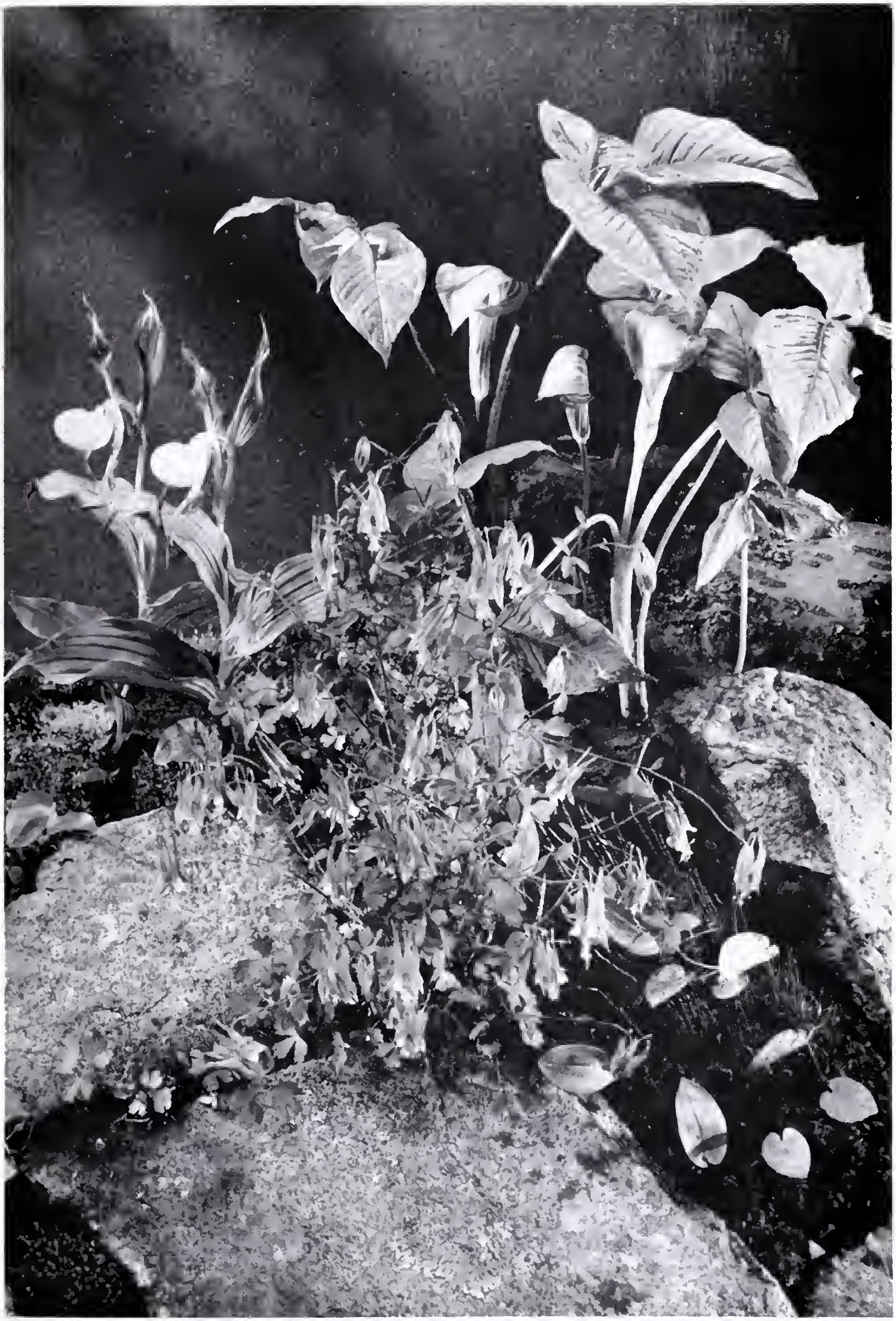
Early saxifrage (*Saxifraga virginiensis*)



Roche

Yellow lady-slippers (*Cypripedium calceolus pubescens*) and Jack-in-the-pulpit (*Arisaema*), with columbine (*Aquilegia canadensis*) in the foreground.

clumps formed by underground runners. It may often be found growing on a rotten evergreen log or stump in swamp lands. Partridge-berry, a trailing plant that is stem-rooting, forms an excellent ground cover, and its small scarlet berries last through the winter. It grows best in a slightly acid soil, preferably with an evergreen-needle mulch. Nursery-grown plants will grow in most soils and even in full sun. Partridge-berry is often used in indoor glass winter gardens (terrariums) along with rattlesnake-plantain (*Goodyera pubescens*), an evergreen member of the orchid family, and small evergreen ferns such as maidenhair spleenwort and walking fern.

McFarland

Wintergreen (*Gaultheria procumbens*)

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Partridge-berry (*Mitchella repens*)

If the garden is semiwoodland, white snakeroot, or snow thoroughwort (*Eupatorium rugosum*) will thrive in a moist pocket along a ledge. It blooms in late August and September, with broad clusters of white flowers resembling double gypsophila.

Ferns

Several native ferns normally grow among rocks and ledges, and readily adapt themselves to the natural setting of the rock garden. They require no fertilizers or special care. A small crevice in a rock or ledge is all that is needed for some; others are able to grow out and over smooth rock surfaces, building up their own soil by trapping blown dust and decomposing fronds.

Ferns, because they are not flowering plants, are rather difficult to describe except as to height, best growing conditions, and general uses. Some are deciduous, others evergreen; but all are very useful and interesting. More of the taller varieties should be used in foundation plantings. Unfortunately many of the small ones best suited for rock gardens are too rare to be available. Many woodland ferns have been seriously depleted because of the opening of woodlands by overcutting of timber, and because of the use of woodlands for grazing to accommodate the great increase in dairy farming.

Fortunately, ferns have been almost uniformly adapted to transplanting; generally, all that is needed is similar soil and moisture conditions; but as with all plants, there are occasional exceptions.

The larger evergreen varieties of ferns should not be overlooked. The marginal shield fern, or evergreen wood fern (*Dryopteris marginalis*) is at the top of the list for the rock garden. Although a fairly large fern, growing up to 2 or 3 feet tall, it thrives in the rockiest soil in shade or in full sun. Its broad leathery

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Foam-flower (*Tiarella cordifolia*)

fronds on rugged stalks will stand nearly all the abuses of the elements, both summer and winter. The new growth in the spring replaces the old in time to avoid any unsightly residue.

The Christmas fern (*Polystichum acrostichoides*), which resembles the Boston fern, grows under the same conditions as the marginal shield fern. It grows to about 2 feet but tends to divide and form larger immediate colonies. Its fronds are glossy green, with stiff stalks which resist covering by the leaves in the fall.

Another evergreen, the toothed (or spinulose wood fern (*Dryopteris spinulosa*), with its delicate lacy fronds, used extensively by florists, prefers moist shade and is generally overlooked. It will thrive for a number of years in dry situations.

Smaller evergreens, more frequently used, are species of *Asplenium*. Maidenhair spleenwort (*Asplenium trichomanes*) finds a home in a moist crevice of limestone rock or in a glass winter garden. Its fronds are carried on slender 2- to 5-inch stalks, and always draw comment. The addition of vermiculite to the soil aids in growing this fern.

Ebony spleenwort (*Asplenium platyneuron*) resembles a miniature Christmas fern. It readily adapts itself to most soil conditions. The several stalks with narrow fronds, growing up to 12 inches tall, are usually surrounded by a rosette of short ones.

The rock polypody (*Polypodium vir-*

Liverleaf (*Hepatica triloba*)—in bloom here—and the Christmas fern (*Polystichum acrostichoides*) both have evergreen leaves. McFarland

ginianum) resembles the Christmas fern in many respects except that it rarely grows more than 9 inches tall. It usually grows in a mat, expanding and covering boulders and ledges; yet it never becomes a weed.

The walking fern (*Camptosorus rhizophyllus*) serves as a point of interest in the garden because of its habit of rooting at the tips of the long tapering leaves (or fronds), making a succession of colonies. This fern grows on limestone rock almost exclusively; it is frequently used in bowl gardens with success.

Deciduous ferns ideal for rock garden use and requiring limestone or neutral soil are *Woodsia* and *Cystopteris*. Rusty woodsia (*Woodsia ilvensis*) does well in full sunlight; the short woolly tufts of light green turn a pleasing rusty red in the autumn. It seldom grows more than 6 inches in height; but planted in groups as it naturally grows, it has proved very popular with gardeners.

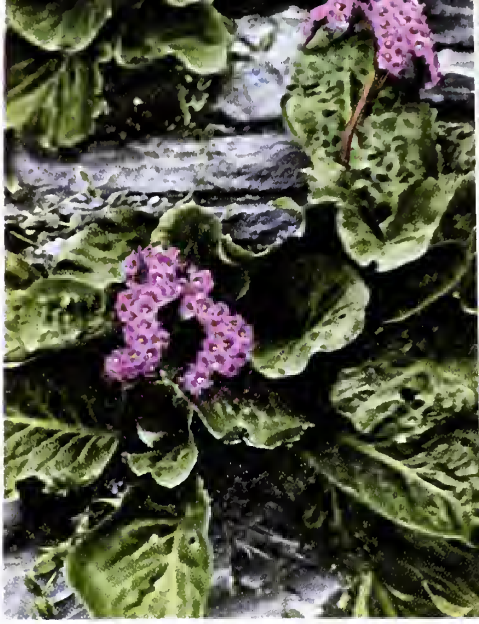
The common woodsia (*Woodsia obtusa*) grows somewhat taller and has the unusual characteristic of starting new growth late in the season; while this does not become fully developed, it reminds one of what to look forward to in the spring.

The bulblet bladder fern (*Cystopteris bulbifera*) has narrow, lacy fronds on long curved stalks. A tumble of rocks or a crevice on a ledge serves as a perfect foil for this fern. Under favorable conditions, preferably limestone, it is soon a thriving colony.

The brittle (or fragile) fern (*Cystopteris fragilis*) is a small edition of the bulblet bladder fern and more delicate in structure. It appears somewhat earlier in the spring and prefers more sunlight.

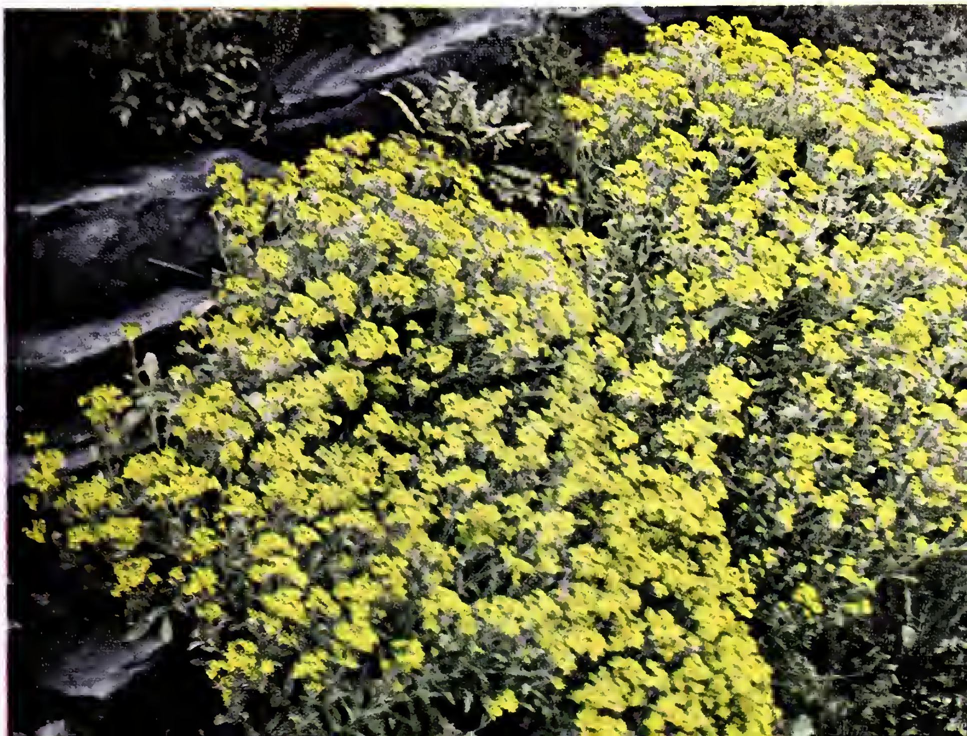
The particular beauty of ferns—their foliage—does not detract from, but accentuates the beauty of the flowering plants throughout the garden. The evergreen ferns lend color in off-season periods, especially in early spring, when green is particularly welcome.

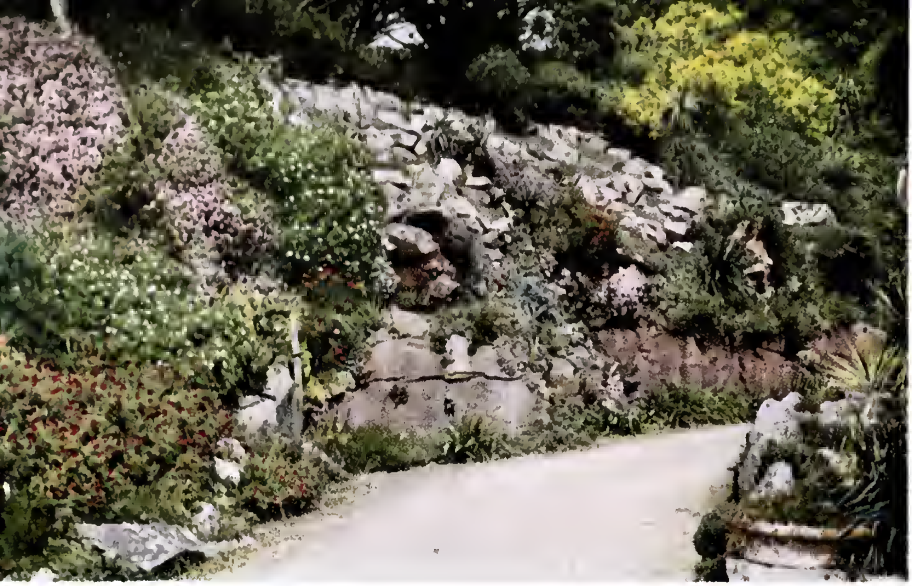
Brittle fern (*Cystopteris fragilis*)



Bergenia crassifolia, sometimes called leather saxifrage, is a rather large rock garden plant, with smooth shiny evergreen leaves; it flowers in early spring on stalks up to 20 inches tall. Its size dictates a background position in the rock garden.

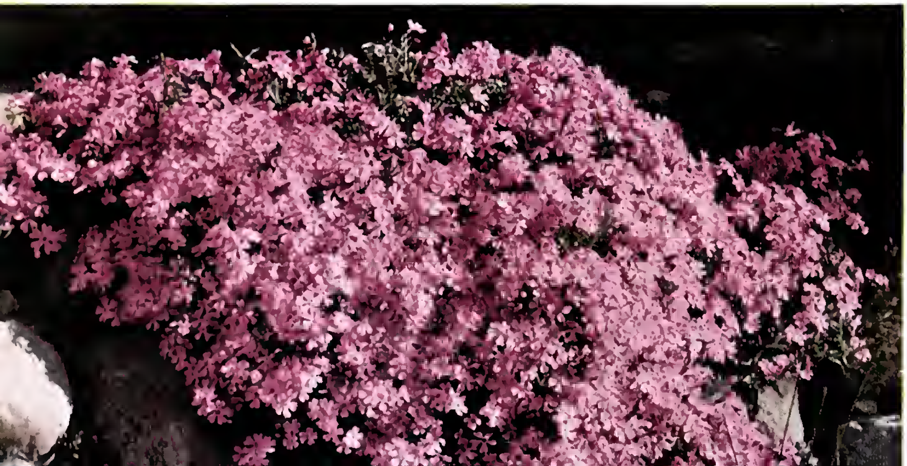
The spreading mats of golden-tuft, or basket-of-gold (*Alyssum saxatile*) should be used in moderation, to brighten the wall garden.





A wall garden in the Scilly Isles, off the southwest coast of England, with plants such as could be grown in California. Plants from South Africa, New Zealand, and Australia. Typical are certain varieties of stonecrop (*Sedum*), houseleek (*Sempervivum*), and groundsel (*Senecio*).

Moss-pink (*Phlox subulata*) has a place in every rock garden. It forms large evergreen mats up to 6 inches tall, and flowers in early spring. The original species is native from New York to North Carolina. Here shown is one of the many horticultural varieties.



The delicate mossy saxifrage, with finely cut leaves, is easy to grow in a well drained limestone soil in a moist atmosphere.

The large flowers of stemless gentian (*Gentiana acaulis*) grow on short stalks close to the ground, in the spring. Like most rock plants, this gentian does best in moist, well drained soil with adequate humus and relatively low fertility.

Gold-moss stonecrop (*Sedum acre*), a creeping evergreen plant that forms mats up to 5 inches tall, and blooms in late spring and summer.

A rock garden planned as a border planting with appropriate shrubs in the background.

Author courtesy

Typical habitat of alpine flowers. Mt. Goliath, west of Denver.

ALPINE PLANTS FROM THE ROCKY MOUNTAINS

General characteristics of these plants and the conditions under which they grow wild. Mention of about fifty kinds suitable for rock gardens

George W. Kelly

WHERE better can we get alpine plants for our rock gardens than from the Rocky Mountains in Colorado? In Colorado, much of the land is turned on edge to make mountains, and there are fifty-two peaks that tower above 14,000 feet. These high mountains collect snow in the winter; through the gradual melting of this snow during the summer, irrigation water is provided for the needs of agriculture and ornamental horticulture in the lower lands surrounding the mountains, where most of the population is located. This high mountain backbone is also the birthplace of several of the great rivers of our country.

Environmental Conditions

In these alpine regions (above timber line or just below) grow many kinds of beautiful flowers, mostly on dwarf plants. To use these successfully in our rock gardens at lower altitudes we must understand the special conditions under which they grow, and try to approximate these conditions in their new environment. In spite of the rocky, unfavorable appearance of their natural habitat, the soil is actually well adapted for the growth of these plants. It is slightly on the acid side; and it is well drained, so that although the plants may get a little rain almost every day, the soil never becomes soggy around their roots. The plants' chief handicap is that they have only a few weeks to make their season's growth and produce their bloom and seed. Most of the alpine plants have very short stems and begin growing as soon as the winter covering of snow has melted. High wind is one thing that tends to keep the plants low and compact. The sun is very bright and hot at this high altitude, yet it is always cool in the shade and at night. Most of these alpine plants grow in the full sun and on steep slopes, but some are found in the shade of rocks and dwarf trees. Others

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Yellow (or worm-leaf) stonecrop (*Sedum stenopetalum*).

grow along the tiny streamlets that trickle off the melting snow, with their roots almost in the icy water.

To grow these choice plants successfully in gardens of lower altitudes, one should first give consideration to building up a mound of soil similar to that in which the plants originally grew. Such a soil can be made with gravel, stone, leaf mold, and a little good soil. Next, a provision for subirrigation or a sprinkler system will save time in watering and help to keep the plants at their best. Some of these plants can be grown for many years under such artificial conditions, but others gradually decline and die without their usual cool nights and short seasons.

Plants

Above timber line, during the growing season in July and August, several of the most conspicuous plants do not look at all like the dwarfed plants that we usually associate with timber line. The large yellow sunflower-like bloom of the alpine goldflower (*Actinea*, or *Rydbergia*, *grandiflora*) is seen as one comes up over the side of the mountain from the southeast. The white tassels of the American bistort (*Polygonum bistortoides*) wave a foot or

Fuzzy thistle (*Cirsium drummondi*).

Charles J. Ott, courtesy of the author

Author courtesy

Woolly actinella (*Hymenoxys lanata*).

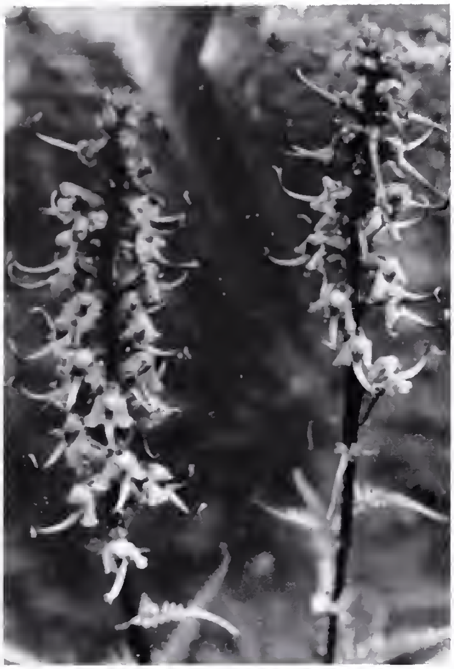
Alpine-lily (*Lloydia serotina*).

Author courtesy

more over the heads of the other flowers; and occasionally one sees the comical little monkey faces of the husky-looking fuzzy thistle (*Cirsium drummondi acaulescens*).

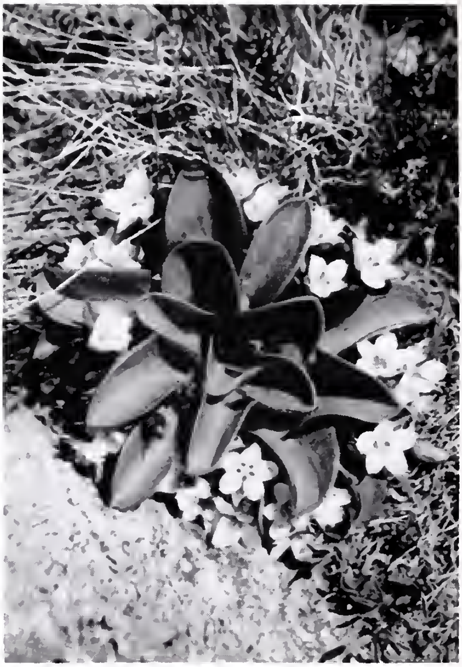
A closer look reveals the delightful little mat-flowers that cover the ground and the cracks in the rocks. The dwarf-forget-me-not (*Eritrichium elongatum argenteum*) is a choice gem not easily forgotten. It grows on the tops of the highest peaks and is brilliant sky-blue, striking as far away as it can be seen. In varying combinations on different peaks and on different slopes, are the ever-present alpine (or tufted) phlox (*Phlox caespitosa*), cushion-pink (*Silene acaulis*), alpine (or tufted) sandwort (*Arenaria verna*), alpine chickweed (*Cerastium beeringianum*), alpine skyrocket, or rock-jasmine (*Androsace septentrionalis subumbellata*), alpine catspaw, or pussys-toes (*Antennaria*), and yellow (or worm-leaf) stonecrop (*Sedum stenopetalum*).

Adding zest to the alpine rock garden are occasional clumps and groups of the tiny dwarf rock-jasmine (*Androsace chamaejasme carinata*), the fairy (or gold-bloom) saxifrage (*Saxifraga chrysantha*), the fairy (or Colorado) primrose (*Primula angustifolia*), with its small



B. Korfhage, courtesy of the author

Close-up of the elephant heads of little red elephant, or elephant-head lousewort (*Pedicularis groenlandica*).



Author courtesy

Alpine spring beauty (*Claytonia megarrhiza*)

magenta flower, the alpine-lily (*Lloydia serotina*), and the beautiful stars of the pygmy breadroot (*Lewisia pygmaea*).

Scattered here and there are touches of dark blue from the blue sky-pilot, or skunkweed (*Polemonium confertum*) and *P. viscosum;* and under the shade of willows and pines, the light blue of the Jacobs-ladder, or skunkweed (*Polemonium pulcherrimum*), with occasional clumps of the alpine chiming bells, or bluebells (*Mertensia alpina*), the alpine harebell, or bellflower (*Campanula uniflora*), the purple pincushion, or mountain scorpionweed (*Phacelia sericea*), and now and then one of the beard-tongues (*Penstemon*).

The little white heads of snowball (or diamond-leaf) saxifrage (*Saxifraga rhomboidea*) and the small-leaved alum-root (*Heuchera parvifolia*) stick up here and there; and the tiny dwarfed mats of some of the parsleys and yarrows, less than an inch high at high altitudes, fill in places where nothing else grows.

Clumps of the alpine paint-brush, or painted-cup, in rose-red (*Castilleja rhexifolia*) and in yellow (*C. occidentalis*), add their bit of bright color; and the woolly actinella (*Hymenoxys lanata*) makes bright patches of yellow with its clusters of cheerful flowers like sunflowers. Tiny flowers of some of the plants of the mustard family, *Arabis, Thlaspi,* and several kinds of *Draba,* fill in with their purple, white, or yellow flowers.

Under the shade of rocks are often found the pink or white flowers of the alpine spring beauty (*Claytonia megarrhiza*), looking out from under the protecting leaves like little chicks under a hen. In this same shady location may be found the tiny bloom of the nodding saxifrage (*Saxifraga cernua*), the alpine mountain-sorrel (*Oxyria digyna*), with its peppery-tasting leaves, or the fronds of the dainty brittle fern (*Cystopteris fragilis*), peeking out from under the rock.

Over all is the dominating yellow of the cinquefoil (*Potentilla*), alpine avens (*Geum*), and related plants, with the mats of alpine clover (*Trifolium*), alpine-daisy, or fleabane (*Erigeron*), and occasional mats of mountain dryad (*Dryas octopetala*) and the dwarf alpine willow (*Salix*).

If one is lucky he may find a few plants of the rare alpine (or Rocky Mountain) columbine (*Aquilegia saximontana*) tucked away in the cracks of the cliffs, or the alpine (or Iceland) poppy (*Papaver nudicaule radicatum*), or the peculiarly folded bloom of the alpine gentian (*Gentiana algida*, or *romanzovi*).

Many other flowers, less common, may be found in particular places if one cares to hunt. Early in the season, just as most of the snow disappears and the other flowers have not had time to develop, many slopes will be covered with a carpet of the yellow bloom of the snow-lily, or adders-tongue, sometimes called dogs-tooth violet (*Erythronium grandiflorum*).

Farther down the mountainside where the trickles of snow water have combined to form little streams, one finds the white (or elks-lip) marsh-marigold (*Caltha leptosepala*), along with its usual companion the white (or western) globe-flower (*Trollius albiflorus*), and groups of the little red elephant, or elephant-head lousewort (*Pedicularis groenlandica*); also the beautiful and lush Parry primrose (*Primula parryi*), the dark red heads of the kings crown, or stonecrop (*Sedum integrifolium*), and the pink heads of the rose crown, or stonecrop (*Sedum rhodanthum*). One might even come upon a group of bog-laurel (*Kalmia polifolia*), monkey-flower (*Mimulus guttatus*), or various buttercups (*Ranunculus*).

Still farther down the mountain, in the timber, there is a great variety of the larger and more conspicuous mountain flowers such as the columbines (*Aquilegia*), bluebells (*Mertensia*), groundsels (*Senecio*), shinleafs (*Pyrola*), beard-tongues (*Penstemon*), alum-roots (*Heuchera*), wallflowers (*Cheiranthus*), arnicas, and orchids—but that is another story.

When a taste has been developed for these tiny alpine gems, the question naturally arises as to where they can be bought. Unfortunately, I do not know. Possibly some of the English nurserymen or seedsmen can supply some of them, for they have known and appreciated our alpine "weeds" much longer than we have. At least, anyone can come and see these beautiful things where they grow wild; and possibly he can collect a few plants or seeds.

White (or western) globe-flower (*Trollius albiflorus*).

Charles J. Ott, courtesy of the author

Author courtesy

Walls in which the author grows rock plants.

ROCK GARDENING IN THE SOUTH

Forty or fifty of the many kinds of plants that can be grown in a dry wall. Information based on ten years' personal experience

Elsie N. Hassan

VERY little information about planting a steep dry slope finds its way into print, and still less about plants suitable for rock gardens in the South. A list of plants gleaned during more than ten years of struggle on a very difficult site in Birmingham, Alabama, may encourage other gardeners to experiment with dry walls. The walls provide good drainage when rainfall is heavy and at the same time conserve enough moisture for a comparatively cool damp root run. This is necessary for many of the plants and agreeable to all. Some of the small plants that are commonly grown in southern gardens make unusually good growth above or below a wall. The rocks also dramatize small plants that need a background to enhance their charm.

The proving ground for the plants discussed was a series of terraces flanked by dry walls 15 to 20 inches in height,

Ries

Rosemary (*Rosmarinus officinalis*)

McFarland

Mazus japonicus

built of flat sandstone. Dry walls are walls laid without mortar, padded instead with thin layers of sifted soil. Pockets are left at intervals, for planting in the face of the wall. Walls are sloped backward toward terraces at an angle sufficient to conserve moisture and to hold the rocks firmly in place. Backing the walls with a sifted soil mixture of equal parts leaf mold, clay, and sand insures good drainage and easy planting. The bed of good soil should be at least 15 inches wide and the depth of the wall. Proportions of the mixture should be varied to suit the requirements of any plants with special needs. Freshly quarried sandstone is raw in color but weathers beautifully in a very short time. It is hospitable to lichens, which soon lend an appearance of mellow age. I used sandstone instead of limestone because I built most of the walls myself, with the aid of a boy, and found the thin smooth slabs of sandstone easier to lift and fit together.

McFarland

Lenten-rose (*Helleborus orientalis*)

Only a small portion of the walls received full sun. Most of them had varying degrees of shade from tall trees. The trees tempered the baking heat of the sun, but the roots depleted the scanty supply of moisture. Even the shadiest walls received good light, as there were no low overhanging branches.

The list represents only a choice fraction of plants grown and only those that have weathered at least five years. Once established, they required watering only in very hot dry weather. Most of them would probably survive without watering on a more hospitable site, but it is a pleasure to see their response to a good soaking when it is hot and dry. Practically all of the plants present a good appearance all the year, and a number are winter-flowering. Many mat-forming plants with showy bloom are omitted because of their tendency to burn out in patches. Many of the plants were chosen for distinctive habit and good foliage rather than for profuse bloom. Late fall is the best planting season.

Roche

Spring star-flower (*Brodiaea uniflora*) may become as tall as 8 inches; its white flowers are faintly tinged with blue. It blooms in late winter in the South.

Low-growing Shrubs and Subshrubs

Rosemary (*Rosmarinus officinalis*) is delightfully aromatic. Its height is easily controlled; with judicious pruning it forms a broad, billowy, evergreen mound, with airy pale blue flowers in winter. It is adaptable, but full sun and good drain-

Squill (*Scilla sibirica*) has rich blue flowers.

age produce magnificent specimens.

Rosemary (*Rosmarinus prostratus*) lies flat on the ground. It is not quite so vigorous as *R. officinalis* but produces flowers intermittently all the year.

Cape-jasmine (*Gardenia jasminoides*), a charming miniature gardenia, sprawls effectively at the top of a wall, blooms for five or six weeks in early summer, and has good foliage all the year. It appreciates watering, light shade, and acid soil—at least half peat moss or compost.

Serissa foetida, a beauty that deserves a better name, is showered with blossoms in April and produces moderate bloom till late November. Its small evergreen leaves and starry white flowers produce an airy, sparkling effect. It is so responsive to pruning that it can be shaped to fit any spot. Light shade.

Winter savory (*Satureja montana*) is an aromatic low evergreen that blooms in late summer and has good small leaves turning wine-color in cold weather. Light shade.

Spring heath (*Erica carnea*), winter-flowering in the South, blooms for many weeks. The type has pink flowers, but forms are available with white or deeper-colored flowers. Its habit and needlelike leaves suggest a fairy conifer. It is drought resistant but responds to watering. Very light shade.

Lavender (*Lavandula* — various species). *L. officinalis* is the most vigorous and the most heat resistant; it succeeds in full sun and requires moderate pruning. It has gray foliage, and all parts of the plant are aromatic.

Lavender-cotton (*Santolina* — various species). *S. chamaecyparissus* has the appearance of gray coral, when pruned to keep its form compact; too long branches become bare at base. Full sun or very light shade.

Little-leaf bearberry cotoneaster (*Cotoneaster dammeri radicans*). Long branches hug the rocks and are jeweled with red berries that last for months (unless chipmunks find them). The plant has small, glossy, evergreen leaves and needs very little pruning. Light shade.

Thyme (*Thymus fragrantissimus*). Most of the bushy thymes thrive, but this is the most vigorous and blooms the most profusely. It has small gray leaves. Sun or light shade.

Vines

Wire-vine, or **maidenhair-vine** (*Muehlenbeckia complexa*) is a very attractive small vine, grown generally as a pot plant, but hardy in the rock garden. It withstands drought but responds amazingly to copious watering. It has long wiry

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Zephyr-lily, or Atamasco-lily (*Zephyranthes atamasco*) has large white flowers sometimes tinged with purple.

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Long-spur epimedium (*E. grandiflorum*)

branches with tiny round leaves; pruning induces branching. Light shade. Seldom listed in catalogs.

Kenilworth-ivy (*Cymbalaria muralis*), with delicate light green foliage and tiny flowers like snapdragons, effectively drapes walls and sows itself in crevices. It is almost evergreen—dies back only in the coldest weather. Shade.

Ivy (*Hedera*): various miniature forms are ideal for planting in wall pockets. Many of these color brilliantly in cold weather; they retain their miniature characteristics and color best in poor dry soil. One miniature found unlabeled in a ten-cent store had such tiny leaves and bright color that it was in constant demand for winter flower arrangements. Shade.

Neat Ground Covers

Savory (*Satureja intricata*) has short curving stems and a very interesting habit; tiny light green leaves, and white flowers for a long period in late summer. It endures heat and drought remarkably well and grows in full sun or very light shade.

Dwarf yarrow (*Achillea nana*) has circles of leaves like tiny gray feathers, which make a cobweb pattern on the ground; inconspicuous white flowers. **Woolly yarrow** (*A. tomentosa*) has showy yellow flowers but lacks the dainty charm of *A. nana*. Light shade.

New Zealand brass-buttons (*Cotula squalida*) has tiny fernlike leaves flat on the ground, with wine and plum tones in cold weather. Its flowers are odd little buttons, but it seldom blooms. It needs moderate shade and occasional watering.

Mazus japonicus has light green rosettes studded with lovely lavender flowers in spring; it spreads rapidly in a moist location. Shade and occasional watering are necessary.

Rock-cress (*Arabis procurrens*) has dark green foliage, and small white flowers sometimes as early as January. Very light shade.

Lusty Growers

Marjoram (*Origanum vulgare* and *O. pulchellum*), with attractive evergreen aromatic foliage, is very good for difficult spots where a comparatively broad surface needs cover. The flowers are profuse but not showy. Sun or shade.

Silver wormwood (*Artemisia argentea*), a taller ground cover, spreads by means of short stolons but is not invasive enough to be a nuisance. It has frosty gray foliage, so finely cut that it resembles silver filigree.

Speedwell (*Veronica*). Various low-growing forms give good cover, and bloom profusely in sun or in shade.

Ceratostigma plumbaginoides (*Plumbago larpentiae*) is herbaceous—dormant in winter; foliage turns brown in fall. It has blue flowers for weeks in summer and is easy to grow in sun or in shade.

Glory-of-the-snow (*Chionodoxa luciliae*) has bright blue flowers with white centers.

Perennials

Blood-red cranesbill (*Geranium sanguineum*) has broad clumps of handsome foliage, and bears rosy magenta flowers all summer if seed pods are not allowed to form. Sun or light shade.

Lenten-rose (*Helleborus orientalis*) hybrids have bold evergreen foliage, and large flowers from January to April, ranging in color from white through tones of pink and mauve to dark purple. The blossoms remain in good condition several weeks and turn green as they age; the seed pods are interesting. The plants grow best at the base of a shaded wall, and many fine self-sown seedlings come up. The Christmas-rose (*H. niger*) survived for several seasons but did not seem suited to the climate.

Epimedium—forms with white, lavender, red, or yellow flowers. Yellow-flowered forms are the most vigorous and have the handsomest foliage. These plants endure and increase in dry shade better than any other plants of equal beauty. When flower buds show above ground in spring old foliage should be removed to display the flowers and colorful new foliage.

Algerian iris (*Iris unguicularis*), a fragrant winter-flowering desert iris, should be grown on top of a wall with sharp drainage to insure summer baking. One 5-year-old clump about 15 inches in diameter produced more than 150 blossoms at intervals from November to April. Each period of mild weather produced a dozen or more blossoms. The type is lavender but other colors are available.

Small Sprawlers

Bony-tip fleabane (*Erigeron karvinskianus*, sometimes incorrectly called *Vittadinia australis*). This is a small perennial, producing miniature daisies continuously for months, and sowing itself in the most accommodating fashion. Sun or light shade.

Golden thyme (*Thymus serpyllum aureus*, known in the trade as *T. citriodorus aureus*). The aromatic foliage is in luminous tones of soft yellow with very little green in the best forms; branches showing much green should be removed to keep the golden tone. The leaves are crisply edged with vermilion in cold weather. Sun or light shade.

Grape-hyacinth (*Muscari*) Heavenly Blue.

Silver thyme (*Thymus serpyllum argenteus*, known in the trade as *T. citriodorus argenteus*). The aromatic leaves are cool white and gray-green, with rosy lavender edges in cold weather. Sun or light shade.

Bulbs

Most small bulbs present no problem except their somewhat unsightly ripening foliage. Those used are too numerous to describe; but the ones mentioned have a minimum of dying foliage.

Common and giant snowdrops	*Allium triquetrum* *Galanthus nivalis* and *elwesi*
Squill	*Scilla*
Hyacinth	*Hyacinthus ciliatus*
Crocus	*Crocus*—fall-, winter-, and spring-flowering
Grape-hyacinth	*Muscari*
Glory-of-the-snow	*Chionodoxa*
Chile-star	*Leucocoryne*
Spring star-flower	*Brodiaea uniflora*
Amaryllis	*Amaryllis advena*, or *Hippeastrum advenum*
Fall-daffodil	*Sternbergia lutea*
Jonquil	*Narcissus jonquilla simplex*
Nodding star-of-Bethlehem	*Ornithogalum nutans*
Zephyr-lily	*Zephyranthes*

ROCK GARDENING IN CALIFORNIA

A plea for the year-round pleasure to be derived from this neglected kind of gardening—based on personal experience

Virginia Stewart

ROCK gardening in California is still in the primary stages, probably because geraniums (*Pelargonium*) and fuchsias bloom so prolifically that the average gardener has overlooked the great satisfaction of cultivating low-growing perennials. Certain kinds of these low perennials give interest every month of the year, even when they are not in bloom, because of their color, their texture, and their natural affinity for their surroundings.

Our garden, situated in the central part of California's coastal region, must endure a long dry summer; the cooling summer fogs act as an air conditioner but add nothing in the way of moisture to the soil. We start our watering in early March and often do not roll the hoses away until November. The temperature in winter often falls to 18° F. During the rainy season, December, January, February, and March, the rainfall usually averages about 40 inches.

Primrose WANDA, a hybrid of the Julia primrose (*Primula juliae*)

McFarland

Winter and Early Spring

The hybrids of the Julia primrose (*Primula juliae*) begin blooming early in January. The variety SCHNEEKISSEN, with its lovely glistening white flowers, often begins in December; it is followed by the varieties ROSEA, EDELSTEIN, WANDA, BUNTY, and others.

The native California rock-cress (*Arabis blepharophylla*) blooms in early January; it is a neat tufted plant with flowers of a clear rose, which must be protected from early marauding snails and slugs.

Most **saxifrages** do well with us, but it is regrettable that some of the early blossoms are ruined by rain. Some day—when time permits—ours will all be equipped with shields for protection. *Saxifraga elizabethiae*, with clear yellow flowers, is the first to bloom, followed in quick succession by *S. jenkinsi, boydi, marginata, frayli, kestoniensis,* BLUSH ROSE, and MARSHALL JOFFRE.

Spring

As soon as the days lengthen, all the old stand-bys of the rock garden rapidly start growing and flowering.

Aubrietas do not give the lavish display here that they do further north, but nevertheless, along with rock-cress (*Arabis*), madwort (*Alyssum*), and yarrow (*Achillea*), they make a lovely carpet or drape themselves with grace over a rock wall.

Phlox. *Phlox kelseyi*, native to Montana and Idaho, a neat low-growing plant with flowers of clear lavender accented by vivid orange anthers, is the first phlox to bloom. Many of the varieties of moss-pink (*Phlox subulata*) do poorly with us; they live and flower but not with much vigor. The trailing phlox and its white variety (*Phlox nivalis* and *P. nivalis alba*) have been in our garden many years and are still showy and thriving.

The **rockery blister-cress** (*Erysimum pulchellum*), with bright yellow flowers over a bright green cushion, blooms early and persists until late spring.

Edging candytufts (*Iberis sempervirens*) Christmas Snow, Snowflake, and Purity, all early-flowering, are indispensable for their good clear white flowers.

Silene. The Wherry wild pink (*Silene wherryi*) has proved quite as reliable as the fall-blooming moss campion (*Silene schafta*). The alpine catchfly (*Silene alpestris*) is a dainty rambler among the rocks.

Liver-balsam (*Erinus alpinus*) is more or less commonplace, but praise enough

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(Top) Glacier pink (*Dianthus neglectus*)

(Center) Cranesbill (*Geranium sanguineum prostratum*)

(Right) Gromwell (*Lithospermum diffusum*)

McFarland

Sun-rose (*Helianthemum*) Rhodanthe Carnea

cannot be heaped on it for its ability to seed itself in just the right chinks and crevices of the rock garden. It sends up stems of pretty little flowers in lavender, pink, and white for many weeks in spring —truly an alpine gem.

Gromwell (*Lithospermum diffusum*) Heavenly Blue and Grace Ward are without equal in the rockery. Well established plants bloom in spring, summer, and fall if occasionally treated to a dressing of bone meal.

Hardy geraniums, or **cranesbills,** also must be well established to do their best. Varieties that do well in our garden are *Geranium endressi, G. cinereum, G. cinereum subcaulescens,* the blood-red cranesbill (*G. sanguineum*), *G. sanguineum album, G. sanguineum prostratum,* and *G. traversi.*

Pinks. No rock garden is complete without a good collection of pinks (*Dianthus*). Keeping flower stalks cut off prolongs blossoming, and in some varieties flowers may be had ten months of the year. The glacier pink (*Dianthus neglectus*), the alpine pink (*D. alpinus*), and Ariel, Little Joe, and Dawn bloom constantly for us, regardless of the season.

Sun-roses (*Helianthemum*) put forth their burst of bloom in an abundant display of color as the weather really begins to warm up. For a good variety in color we have planted Goldilocks, American Beauty, Apricot, New Bricks, Rhodanthe Carnea, Wendel's Rose, and Ben Nevis, excluding all double varieties.

Irises. The crested iris (*Iris cristata*) flowers fleetingly in May, with lovely lavender blossoms, as do the slender iris (*I. gracilipes*) and the Russian iris (*I. ensata*). Earlier in the year the western native *Iris innominata,* in a beautiful and interesting variety of colors, puts forth blossoms for many weeks. All low-growing irises are fine rock garden subjects. This year *Iris sindpur* put forth glamorous smoky lavender blooms for the first time early in January. The English gardeners tell us that this iris is not a permanent kind; it may well be that we have taken our last long look.

The early bellflowers also come in May. The Dalmatian bellflower (*Campanula portenschlagiana*) comes first and always gives an abundance of bloom for weeks, with a smaller showing in early fall. Following close on the heels of this come *C. elatines and C. elatines garganica;* both send forth sprays of starry blue flowers from mats of attractive foliage. A newcomer to our garden which has proved most successful is *C. kantschavelli,* with rich amethyst blossoms over gray-green foliage; as the stems are trailing, the next planting will be on a rock wall.

Summer

Later bellflowers: Coming between the spring-flowering kinds and the fall varieties, *Campanula poscharskyana** gives a robust burst of bloom for three or four weeks; if the sprays are continually pulled off, the plant will produce scattered blossoms later. Other bellflowers that do well with us are the Olympic bellflower (*C. rotundifolia olympica*) and the low-cluster bellflower (*C. glomerata acaulis*). The tussock bellflower (*C. carpatica*) and its varieties bloom until heavy frost. *C. cochlearifolia* MIRANDA blooms in July, with dainty porcelain-blue bells, a real rambler among the rocks. *C. pseudo-raineri* is permanent and good provided snails can be kept away. The Italian bellflowers (*C. isophylla* and *isophylla alba*) bloom in the fall, and both are very lovely trailers needing some shade; the fragile bellflower (*C. fragilis*), also a late trailer, tolerates more sun.

Thymes do particularly well in our climate, and we grow many as ground covers. A recent addition to our garden is the showy paper thyme (*T. membranaceus*); not being a long-lasting perennial, it must be propagated every few years or so but it is well worth the trouble it takes. It is indeed unique—a small shrubby plant only 6 inches high, with glaucous leaves, and white flowers subtended by large paper-white bracts.

Fall

Cyclamens. As the year moves on and the full burst of spring and summer bloom is over, cooler days bring the hardy *Cyclamen neapolitanum* into bloom. This lovely little cyclamen does equally well planted out in a cool spot or used in pot culture. The underground parts grow slowly and so frequent pot shifting is not a problem. The flowers appear before the leaves. About midway during the blooming season the leaves begin to develop, and they remain on the plants through the winter and spring; they make a fine

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*Beware: this plant often suckers and spreads like a weed. See page 255.—ED.

McFarland

Heronsbill (*Erodium chamaedryoides roseum*) winter ground cover of beautifully mottled green and silver. *Cyclamen neapolitanum* seeds itself prolifically and makes good-sized colonies. *Cyclamen coum* blooms in late autumn and has rosy purple flowers. *Cyclamen europaeum* blooms in summer and fall, with fragrant red flowers; it is one of several kinds that we grow in pots but will one day entrust to the garden. All varieties are hardy in our climate.

Heronsbill (*Erodium chamaedryoides roseum*) blooms almost continuously in our garden and makes neat low plants, with pink flowers veined deep rose; it is a most desirable plant for full sun in the rockery.

The gaudy **Spanish-shawl plant** (*Schizocentron elegans*), a Mexican creeping herb, is not entirely hardy here; but by planting it near an evergreen shrub which gives protection from frost, we manage to carry it over our winters. The abundance of magenta-rose blossoms produced over the summer and fall months make this plant a good addition to the shadier parts of the garden.

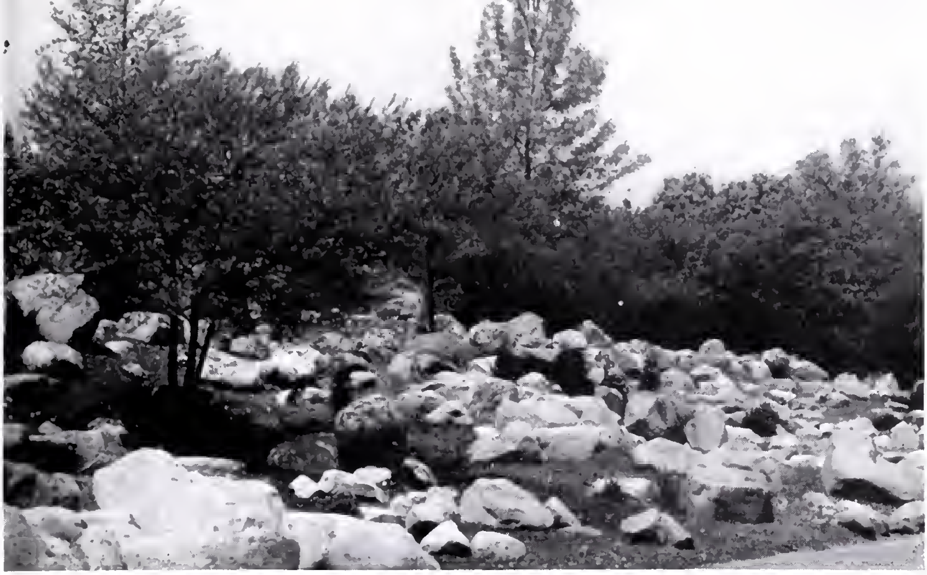
Frankenia capitata laevis is another long-blooming creeper (from the marshes of South Africa) which is hardy enough for our winters. It is a heathlike plant, in almost constant bloom from early spring until heavy frost. The flowers are clear sparkling pink and make an attractive mat over the soft gray-green foliage. Full sun and plenty of water are essential.

The rice-flower (*Pimelea coarctica*), from New Zealand, is very low-growing; it forms dense mats of glaucous foliage with abundant small white fragrant flowers. In our garden it does well in full sun, but it will succeed in some shade also.

This is but a small portion of the material we grow in our California rock gardens. Many plants not mentioned are still in the experimental stage, and so we hesitate to make a statement either for or against their desirability. Gentians we grow with varying success. Ramondas and alpen-clocks (*Soldanella*) do not bloom well with us. Most of the rock-jasmines (*Androsace*) do very well. Some day we might have the good fortune to grow and flower the dwarf-forget-me-not (*Eritrichium nanum*), the dream of every rock and alpine gardener.

Cyclamen neapolitanum

Roche



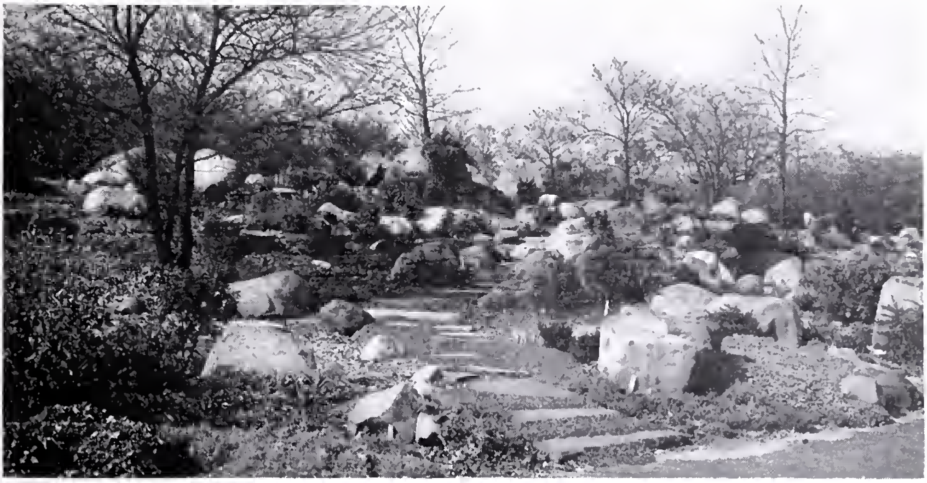
The forbidding accumulation of rocks on which a garden was started.

A ROCK GARDEN IN THE CITY

Experience has shown that disadvantages can be turned into assets

Alys Sutcliffe

A ROCK garden in the center of the city, made of glacial boulders! Many of the early rock garden specialists would shudder at the thought. These early specialists brought limestone rocks from far afield if they could not obtain any near at hand. Limestone weathers well; and the creeping plants cover the surface



The same site as shown above, sixteen months later.

and send their roots down into the crevices where the moisture accumulates.

Glacial boulders do not hold moisture. Hard and bleak, they are so hot in the summer that they burn the hand that touches them. In the winter they are cold and repelling. The small alpines seem to avoid them, growing into each other for the protection or shade they need.

The glacial boulders in the rock garden at the Brooklyn Botanic Garden are part of a terminal moraine, brought down in the ice age. A moraine is a good place for rock plants (page 212) but the large glacial boulders are far from ideal for mak-

Roche

Snowdrops (*Galanthus nivalis*)

Crested iris (*Iris cristata*) has blue flowers with yellow and white crest.

Slender iris (*Iris gracilipes*)

ing a rock garden. The boulders were here, and something had to be done with them. A rock garden was made, for better or for worse.

Further adverse conditions, in the form of city atmosphere, hot humid summers, and alternating freezing and thawing in the winter, add to the difficulties of growing choice alpines in this rock garden. However, many plants do grow and flourish here. Some of them, to be sure, would be looked down upon by the specialists; but such plants as blue phlox (*Phlox divaricata*), golden-tuft, or basket-of-gold (*Alyssum saxatile*), and edging (or perennial) candytuft (*Iberis sempervirens*) in drifts across the garden, help to give color in the spring, break the severity of the rocks, and act as a protection for some of the less vigorous-growing things.

The flowers of edging (or perennial) candytuft (*Iberis sempervirens*) are pure white.

Crocuses, Tulips, and Irises

The planting is carried out to give a natural over-all effect: vigorous-growing plants are kept under control; and others are allowed to have their way, seeding or spreading wherever they will grow. For instance, some time in February, in a sheltered corner, two or three plants of *Crocus tomasinianus* are blooming; by the end of March they have sprung up almost all over the rock garden—between the rocks and under trees along the sides of walks, in two's or three's or in large

Fall-daffodil (*Sternbergia lutea*)

Crocus zonatus has flowers of a peculiar pinkish lilac color, with purple veins and with orange spots inside. Flowering in late November, it is the last of the rock garden plants to bloom.

This large flat rock overhangs a small cavern and pool.

masses; these small species crocuses truly give the effect of an alpine meadow. Coming through the snow, about the same time as the earliest *Crocus tomasinianus*, snowdrops also forecast the spring.

The species crocuses, the species tulips, and the dwarf irises are the great standbys in the city rock garden. They flower early; on crocuses and tulips the leaves soon disappear entirely, and the irises have tough leaves; hence these plants do not suffer from the heat and humidity that affect many plants with soft or woolly foliage.

Crocuses and tulips, squills and glory-of-the-snow give us at least two to three months of color in the spring. Irises start almost as early as the early crocuses, with the bright blue *Iris histrioides* leading the way by flowering in the middle of March. A group of this charming little iris lived and flowered for a great many years but finally gave up when it had been dug up two or three years running to be put into the flower shows.

The netted iris (*Iris reticulata*) flowers very soon after *I. histrioides;* and since not many gardens have *I. histrioides, I. reticulata* is usually the first iris to blossom in this region. Its dark purple flowers open just before the curious triangular leaves come up like spikes. As it is a bulbous iris, its leaves disappear entirely later in the spring.

The crested iris (*I. cristata*) and the white crested iris (*I. cristata alba*) follow; and the various-colored dwarf irises (*I. pumila*) come along soon. After them the slender iris (*I. gracilipes*) opens its small mauve flowers on slender 6-inch stems. About the end of May the roof iris of Japan (*I. tectorum*) comes into flower, growing on rocks covered with bearberry (*Arctostaphylos uva-ursi*). This iris seeds itself amongst the old leaves and stems of the bearberry, which form a sort of thatch over the rocks and take the place of the thatching on the roofs of Japanese houses where this iris grows abundantly. The fact remains that these self-sown plants do much better than any that are planted in soil however well drained.

Some of the species tulips give the brightest touch of color, with brilliant reds and yellows; others are small and delicate in color. Most of the tulips are not so permanent as the crocuses and irises. They need a dry sunny bank so that the bulbs can ripen thoroughly. Some of them come up year after year.

Squills, Glory-of-the-snow, and Grape-hyacinths

Squill (*Scilla sibirica*), and glory-of-the-snow (*Chionodoxa*)—of which there are two or three species—add beautiful patches of blue to the early spring landscape. The foliage of all the small-flowering bulbs mentioned dies very quickly and does not spoil the effect of the later-flowering plants. The same cannot be said of grape-hyacinths (*Muscari*), which should never be planted in the rock garden proper but should be kept well on the outskirts; their foliage is a nuisance most of the season, and the plants are most prolific propagators.

The fall-daffodil (*Sternbergia lutea*), with the leaves of a small daffodil and the flower of a large golden crocus, brightens September days, along with the autumn-crocuses (*Colchicum*) of different kinds. But the true crocuses end the season—as they began it—for *Crocus speciosus* and *C. zonatus* flower up to Thanksgiving Day.

Other Plants

During the spring and summer certain other plants have proved their worth under poor conditions in the rock garden. The following are a few of these. Creeping gypsophila (*G. repens*) and mouse-ear gypsophila (*G. cerastioides*); the latter looks most unlike a gypsophila, forming low fat cushions covered with starry flowers. Creeping speedwell (*Veronica repens*), with small spikes of brilliant blue, spreads over the ground. Some of the small bellflowers (*Campanula*) do fairly well; *C. elatines garganica* is most satisfactory; if planted facing north or with slight shade, it hangs between the rocks with a blue sheaf of flowers.

Numerous low-growing heaths (*Erica*) and heathers (*Calluna*), in a section of the garden where the soil is mostly peat moss and sand, provide color through the season both in flower and in foliage. Cotoneasters, low-growing azaleas, brooms (*Genista*), and evergreens help to soften the look of the larger boulders.

Winter in the boulder garden.

These are but a few of the rock garden plants that are attractive and will grow under difficulties; some of them might even become a nuisance under good conditions.

HERBS FOR THE ROCK GARDEN

Descriptions of fifteen kinds suitable in size, habit, color, and leaf form; with notes on their culture and propagation, and methods of restraining them when necessary

Freda J. Shoupp

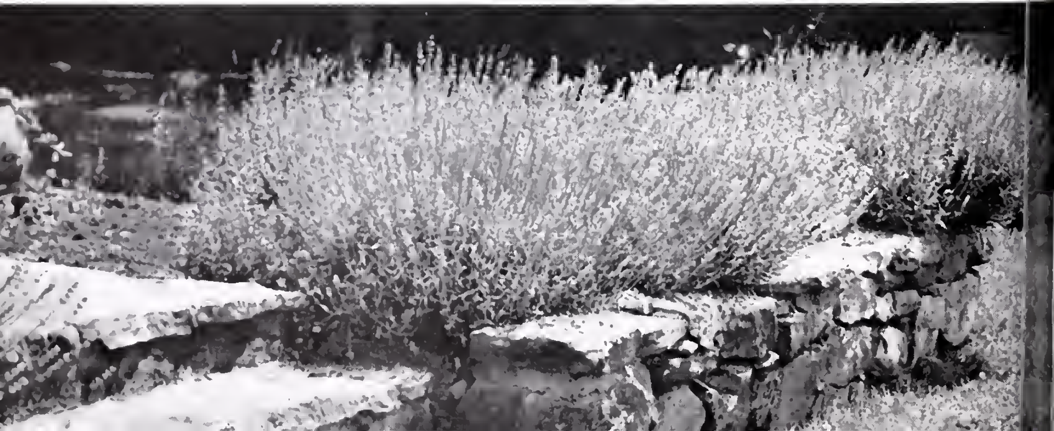
SMALL herbs need to be planted where they can be enjoyed at close range, and so a rock garden makes an excellent location for them. Their coloring and leaf forms are as attractive as those of the alpines, and they have the advantage of thriving in the hot summer sunshine.

Dittany of Crete (*Origanum dictamnus*), with its procumbent (trailing) branches, needs the protection of a rock garden or a dry wall to keep its velvety gray leaves from being splashed with mud. It should have a place in the sun, where the leaves will dry rapidly after a rain. It is not hardy where temperatures go below freezing; but since it makes an excellent house plant, it can be carried over indoors. Three-inch tips root readily in water during early spring and supply new plants.

Sweet marjoram (*Majorana hortensis*) makes an erect dainty little bush averaging 10 inches in height and breadth by late fall. It always presents a neat tidy appearance. The tiny green balls atop its stems, from which lacy white blossoms emerge, add to its interest. It will not survive freezing weather, and so it also must be carried over as a house plant. New plants may be started from cuttings each spring. Sweet marjoram may be grown from seed also, but this is a much slower method of propagation.

Common thyme (*Thymus vulgaris*), the

Lavender (*Lavandula officinalis*)



culinary thyme, is excellent for the rock garden—both the green broad-leaved English form and the gray narrow-leaved French one. Since these are little shrubs, they never create a problem by running over their neighbors as do the creeping thymes. They are usually winter hardy but do best with the protection of an evergreen branch during the winter.

Lavender (*Lavandula officinalis*) has long been recommended as a small shrub for the rock garden. It seems to thrive in lean, well drained, limy soil and is less likely to winterkill in the rock garden than in the perennial border. When grown in the open, it needs protection from strong winter winds and sunshine. Shelter can be furnished by a few evergreen branches stuck in the ground around the plant. In very small rock gardens the less robust white- or pink-flowered forms may be preferred.

Winter savory (*Satureja montana*) makes a most decorative hardy little evergreen for the rock garden. In a lean soil it seldom grows more than a foot tall. It requires very little care but remains more compact if it is sheared back to about 4 inches early each spring. Its dainty white flowers, sometimes tinged with pink, are scattered among the bright green leaves all through the autumn. It is self-sown but never to the extent of becoming a nuisance.

The saffron crocus, or **true saffron** (*Crocus sativus*) furnishes attractive fall bloom in the rock garden. It has lavender cup-shaped flowers with orange-scarlet stigmas. The narrow grasslike foliage disappears by midsummer. The small corms should be planted during August in rich, light, well drained soil in a sheltered spot.

Salad burnet (*Sanguisorba minor*) may be grown in a sunny spot in the rock garden where the soil is poor and dry. Its blue-green fernlike leaves are almost evergreen. The thimble-shaped blossom heads on long slender stems are attractive; and if they are out of scale in a small rock garden they can be clipped out without detracting from the beauty of the plant.

Common hoarhound (*Marrubium vulgare*) is suitable for the rock garden. It can be grown in light poor dry soil in sun or in partial shade. It makes a small shrubby plant with somewhat decumbent (trailing) stems covered with white down; the round crinkled green leaves are downy, too, but to a lesser extent. Old plants winterkill, and so new plants

McFarland

Chives (*Allium schoenoprasum*)

should be started from seed every two or three years.

Chives (*Allium schoenoprasum*) are dainty enough for any rock garden when grown with only five or six small bulbs in each clump. Their small lavender pompon flower heads are most attractive; but they should be cut as soon as they fade, to prevent spreading by seed.

Parsley (*Petroselinum crispum*), with its vivid green curly leaves, looks attractive, tucked among the rocks, a plant or so in a spot. The seed stalks may be cut out as soon as they form.

Salad chervil (*Anthriscus cerefolium*) may be used in the rock garden in a moist shaded area. Its fernlike leaves are small and dainty and persist long into the winter. It is a hardy annual, one of the first plants to start growth in the spring; seed must be sown during the early summer each year.

The Corsican borage (*Borago laxiflora*) is a dainty alpine suitable for the rock garden. It is a perennial, with green spiny leaves, and decumbent branches bearing blue or violet flowers. The common culinary borage is far too coarse for rock garden use.

Bush basil (*Ocimum minimum*) adds a bit of bright green to the rock garden. It naturally grows into a very rounded little "bush" usually reaching about 8 inches in height. The **purple bush basil**, with the same growth habit but with very dark purple leaves, adds a color seldom found in the rock garden. These are both tender annuals and must be started from seed each year. Plants with the smallest leaves and deepest coloring are best for the rock garden.

Lavender-cotton (*Santolina chamaecyparissus*) is very attractive, with almost white leaves, and branches that resemble coral. It should be included among the rock garden herbs even though it requires pruning to keep down its size. Once established, it normally makes a spreading plant of 2 feet or more. It requires dry, light, well drained but moderately rich soil in full sun. Even with winter protection it is not always hardy.

These fifteen plants borrowed from the herb garden can furnish new plant material for the rock garden and open a new field of interest for both the herb enthusiast and the rock gardener.

Lavender-cotton (*Santolina chamaecyparissus*)

McFarland

McFarland

Mother-of-thyme (*Thymus serpyllum albus*), one of the hundreds of shrubby species in the mint family.

SHRUBS FOR THE ROCK GARDEN

Deciduous and evergreen; erect and trailing; with leaves and stems of various colors; some with ornamental fruits

Richard J. Darling

WHAT do we want in a shrub for the rock garden? Interesting foliage is probably the primary requisite; showy fruits or flowers are a nice bonus. There is a wealth of character and a suggestion of age and permanence in a rock planting in which dwarf shrubs are artistically displayed. The rocks and shrubs form a skeletal framework, or setting, in which the more colorful and variable herbaceous material creates its pattern.

It is well to note that many of the herbaceous plants suitable for rock gardens have taken on a shrublike habit and appearance because of the harsh environmental conditions under which they have evolved. Plants such as creeping madwort (*Alyssum repens*) and twin-leaf saxi-

Woolly thyme (*Thymus serpyllum lanuginosus*), a very satisfactory rock plant.

Ries

McFarland

Scotch heather (*Calluna vulgaris*)

frage (*Saxifraga oppositifolia*) are not under consideration here; for there are many suitable plants that are indisputably woody throughout, with twiggy branches, bearing the buds of new growth and of flowers aerially, to be distinguished therefore from those that are woody only at the base.

Sun-roses (*Helianthemum*) are of this truly shrubby character. The leaves are small, narrow, and virtually evergreen. The flowers are showy and pretty—hence the vernacular name. Generally they are seen in shades of red, orange, or yellow, or in white, single or double. The common species is *H. nummularium* (with many varieties), a depressed much-branched mound with a spread of about 3 feet. A choicer species, with the leaves a fuzzy gray, is the hoary sun-rose (*H. canum*). The soft yellow flowers are smaller, to be sure, but the plant is far more compact than the common sun-rose.

Beard-tongue (*Penstemon*) has several species that are shrubby, with evergreen or persistent foliage. One that is rarely seen nowadays is the rattan beard-tongue (*P. rattani minor*). This is a charming plant with small dark leaves; it gradually spreads into a mat of twiggy branches only 4 inches or so high until the flowering stalks appear. The purple flowers are not wheel-shaped, with separate petals, as in sun-rose, but are tubular, two-lipped, and tiny, in slender few-flowered clusters. A beard-tongue commoner in cultivation is *P. menziesi,* with flowers blue-purple and more open and a good deal larger than in *P. rattani minor.* The height is about 6 inches, and the leaves are toothed and are larger, thicker, and glossier than in *P. rattani minor.* The garden effect is therefore quite different.

The conifers, surprisingly, offer but few plants that may be brought into the foreground of the rock garden. Certainly a special place should be reserved for the fascinating tennis-ball cypress (*Chamaecyparis obtusa juniperoides*) or for *C. obtusa minima,* which is similar but less dwarf. In this case, it would seem, the bigger the name the smaller the plant, for the tennis-ball cypress does not exceed 6 inches of growth in height throughout a lifetime of gardening.

Deciduous shrubs. Certain ones, such as the lowbush blueberry (*Vaccinium angustifolium laevifolium*) are scarcely to be recommended. When they leaf out in the spring, too much else is going on in the rock garden to allow them much attention; and so the daily changes in color and position of leaves are not likely to be noticed.

The poplar stonecrop (*Sedum populifolium*) is very desirable for the rock garden. It is unlike its closest of kin in many ways. The low spreading reddish branches are woody, from a central root, and the thick toothed leaves are reminiscent of those of poplar trees. The summer flowers are white, in the usual flat-topped cluster about a foot high. The plant deserves wider recognition.

The Blue-Ridge St. Johnswort (*Hypericum bucklei*), a low shrub from North Carolina and Georgia, is another fine example of a deciduous shrub. This is one of the best for rock gardens, seeming to be possessed of a certain modesty and upright dignity; it has small yellow flowers in early summer.

While these are representative of a small group of deciduous shrubs of merit, the value of evergreen foliage in the somewhat static form of gardening under discussion cannot be gainsaid.

The mint family is very obliging, offer-

McFarland

Sand-myrtle (*Leiophyllum*)

ing hundreds of shrubby species, a goodly proportion of which are dwarf broad-leaved evergreens. Because of the frequent production of aromatic oils by these plants, the nose is a decided help in identifying species of thyme, savory, rosemary, and the like.

For bulb cover, and such uses, the more prostrate kinds, like varieties of mother-of-thyme (*Thymus serpyllum albus* and *T. serpyllum lanuginosus*) are much to be preferred over kinds that form deep 6-inch mats with ascending shoots. These larger sorts do not usually belong in a rock garden, unless upright and tufted, like *T. zygis sylvestris*, for they spread far too rapidly to be kept easily in control. The typical mother-of-thyme (*T. serpyllum*), with prostrate shoots 1 to 2 inches tall, turns a bronzy-purple color after frost. When placed near a large rock, the plant hugs the ground and clothes the rock in a charming way. A plant of distinct appearance is *Thymus comosus*, bearing heads of large rose-violet flowers in July.

Closely related to thyme is the alpine savory (*Satureja alpina*), but the flowers are larger and bluer. The spicy scent of the leaves is different, too.

Some of the germanders, with the flowers still larger, and the leaves sometimes glossy, are excellent shrublets for the rock garden: the mountain germander (*Teucrium montanum*), the golden germander (*T. aureum*), and the Pyrenees germander (*T. pyrenaicum*).

Lavandula officinalis compacta is a hardy strain of sweet lavender. This plant, though dwarfer than the type, is still large, more on the order of sage and rosemary. It needs plenty of room, though it arises from a single woody trunk. The blossoms may be harvested for sachets. All these labiates (members of the mint family) are for a sunny exposure.

Rose family. Mention must be made of the bearberry cotoneaster (*Cotoneaster dammeri*) for its dark and glossy evergreen foliage resembling that of box, and its scattered red berries, but particularly for its rock-hugging habit which gives a fine authentic character to the planting. Another excellent genus of the Rosaceae for the rock garden is rock-mat (*Petrophytum*), any species of which makes a perfect tidy mound of evergreen foliage. The rock-mats are native shrublets of western United States. The flowers are white, in clusters like those of spirea.

The heath family is foremost amongst those clans that contribute dwarf shrubs to the rock garden. There is a universal appeal in many of these small shrubs, although not all are as easy to grow as spring heath (*Erica carnea*). An acid soil with open exposure and some moisture is about all that this plant requires. This shrub is one of the commonest of numerous treasures in the heath family, and deservedly too, for its sets a high standard of beauty and cleanliness. Not everyone is aware, however, that largely through selection the spring heath is now available in a myriad of different forms, showing variation not only in foliage hues, but in stature, flower color, doubling of the corolla, and flowering date. The pink heather-bells appear in earliest spring while frost is still upon the plant.

Scotch heather (*Calluna vulgaris*) occurs naturally in variable forms; many of these are in cultivation as named clons, which may be sought out in specialists' catalogs. Heather bells come in summer, from June through August. Related plants such as spike-heath (*Bruckenthalia*) are also suitable for rock garden cultivation. Besides these, which have fine evergreen foliage like that of the conifers, there are many broader-leaved genera in the Ericaceae (heath family) that should be considered for inclusion.

The alpine-azalea (*Loiseleuria procumbens*) is not too difficult when well established, but it must have summer moisture. Unlike the true heaths, this arctic alpine is native to the Western Hemisphere as well as the Eastern, being of circumpolar distribution. The charm of the tiny-leaved, pink-flowered plant is well known. It likes a cool acid soil and is very dwarf.

The Allegheny sand-myrtle (*Leiophyl-*

lum lyoni) is somewhat like the alpine-azalea, but it has small white flowers in flat clusters. It is native to the mountains of North Carolina and Tennessee.

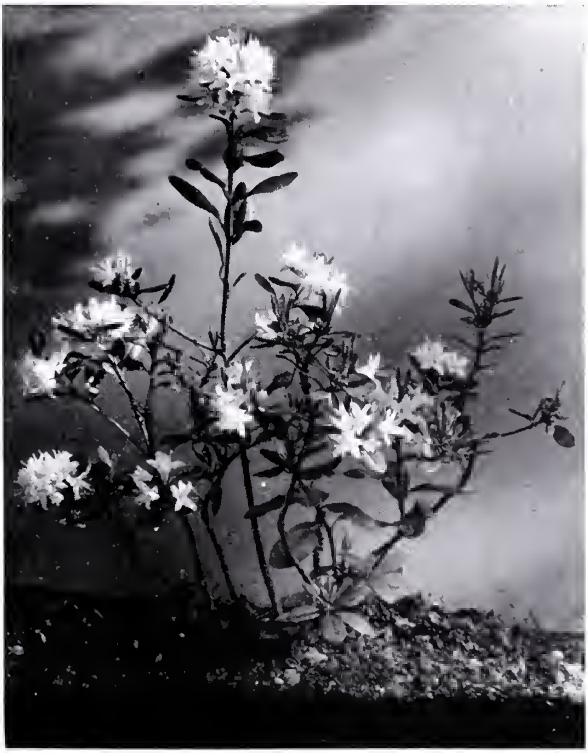
The cowberry (*Vaccinium vitis-idaea*) and the mountain cowberry (*V. vitis-idaea minus*) are very different from the foregoing; they have close-set leaves like those of box, and red berries instead of dry capsules.

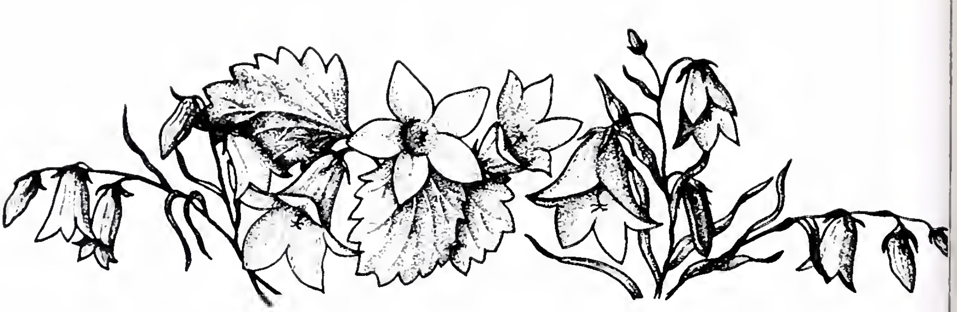
About fifty or sixty species of *Rhododendron* are dwarf enough for the small rock garden. Few of these are in cultivation, however; and many of them either are not hardy or are of difficult culture. Two of the best for the present purpose are the Mayflower rhododendron (*R. racemosum*) and the pincushion rhododendron (*R. myrtilloides*). The mayflower rhododendron is a variable plant with slender clusters of pink to white flowers. It can sometimes be obtained in a dwarf clon, only 12 inches high. The pincushion rhododendron has plum-colored flowers and is only 4 inches or so tall. Many members of the Lapponicum series are also very suitable; all of them like a cool moist soil; and our species, the alpine Lappland rhododendron (*R. lapponicum*), must be kept out of summer heat at sea level.

Many other plants, in the heath family and in other families, must be omitted here: plants such as mountain-heath (*Phyllodoce*), box huckleberry (*Gaylussacia brachycera*), *Pachistima canbyi*, crowberry (*Empetrum nigrum*), and broom crowberry (*Corema conradi*). But enough have been given to show that a fancier's rock garden might be planted with just such material alone, so beautiful and varied are the many dwarf shrubs. It is true that not all of those described in books are offered today by the nurseries, and some are so difficult to grow that they tax our skill. But these difficulties should be only a challenge to the fancier; and there are plenty of suitable dwarf shrubs available for the amateur.

Mayflower rhododendron (*R. racemosum*)

McFarland





ALPINE BELLFLOWERS

The "Royal Family" for the rockery—a great variety of kinds, from the easiest to the hardest to grow

E. Bissett Lovelock

BELLFLOWERS (*Campanula*) are among the most popular of rock garden plants and include some of the prettiest plants grown. Some of them are easy enough to grow in a cupboard, others hard enough to exasperate the expert.

I have never grown bellflowers in a cupboard—only in a parcel. A parcel of unusual varieties arrived an hour or so after the family had set off on their annual holidays. A fortnight later the plants, in their parcel, were still living (though brittle) and had turned completely golden. Planted out, and watered not too liberally, they recovered—all but one. That one died only because of cold water on a

Campanula allioni

warm night—one of the rock world's worst (and least suspected) enemies.

Very Difficult

It is possible that such treatment might succeed with *Campanula allioni;* there is no other that is guaranteed to produce results. This charming plant has the bells of a Canterbury bell (*C. medium*)—but no saucer—and the stature of *C. cochlearifolia* (*C. pusilla*). In fact, it looks as if the big garden bellflower had been blown down and had managed to raise its individual flowers from the ground on short stalks.

The amateur would be ill advised to start with *C. allioni,* which needs sun, a gritty soil, an undergrowth of not too vigorous carpeters, and (apparently) careful experimentation before it can be made at home.

Too Easy

The person that has never grown a bellflower might be well advised to buy a plant of *C. poscharskyana* and plant it anywhere. By August he will have grown thousands. This plant is a great favorite with those who have tried it. It resembles a new but willing gardener's boy, who does pounds' worth of damage but is always doing his best. Poscharsky's bellflower is always doing its best—its best to produce pale lavender stars all over the whole rockery, and its best to crush every other plant in the garden. It does this by sending its stems towering above any plant in its way and falling on it. The choice plant is soon forgotten and the mangled remains are discovered the next winter. Incidentally, the only plant it cannot treat thus seems to be the houseleek (*Sempervivum*); I have one growing next to a bank of the campanula that has survived its attentions for years.

Nevertheless, *C. poscharskyana* is such a willing worker that one can forgive it and grow it in a difficult part of garden—whence it will travel to the best part by the shortest route. It is a good plant to start with and is sure to succeed.

The beginner who has grown Poschar-

Ries

Dalmatian bellflower (*Campanula portenschlagiana*)

Campanula caespitosa

Campanula elatines garganica

McFarland

sky's bellflower will not have established himself as an alpine connoisseur—or anything else, except that he has a garden with soil in it. Much the same applies when he grows *C. portenschlagiana* (*C. muralis*). This has bells instead of stars, violet instead of lilac, and is a little smaller and better behaved. Otherwise it is much like Poscharsky; but strangely enough it is as common in gardens everywhere as Poscharsky is scarce. There is no reason for this except that it appears to have an easier name, when it is called by its alias "*C. muralis.*" Many of the campanulas have numerous aliases and many types are very similar.

Easy

The low-cluster bellflower (*C. glomerata acaulis*) is easy to grow. It has a 9-inch stalk with bells like those of *C. portenschlagiana* but deeper, all gathered together on one head. It grows easily and spreads quickly; it is not (to the writer) very pretty, but certainly has a good color.

Plants can be much harder to grow than any of these and still be very easy; such plants are the "harebell" (*C. rotundifolia*), the tussock bellflower (*C. carpatica*), the dusky bellflower (*C. pulla*), and *C. sarmatica*, *C. arvatica*, and *C. cochlearifolia.* Give them, in some degree, gritty soil and sun and they will manage well; and throw in a handful of peat for *C. pulla* and its dark relatives *C. pulloides* and G. F. WILSON, for these unnatural bellflowers like acid soil.

C. rotundifolia is supposed to be the wild harebell but looks nothing like this dainty plant; it sports a spire of dingy violet hanging bells all the way up its 18-inch stem. Other plants not unlike it are *C. rotundifolia hosti*, the flax-leaf bellflower (*C. linifolia*), *C. scheuchzeri*, and a lot of others. *C. sarmatica* has larger, deeper bells and a more drooping habit but is fairly similar. There are white forms of most of these that are very charming.

A much better "harebell" is *C. cochlearifolia*, which is like a miniature wild harebell and has the same faint blue color. It has grace and soon makes large clumps;

its white form is slightly better except that it is hard to keep through the winter. A similar one is *C. caespitosa*.

Sufficiently distinctive to be worth growing is *C. arvatica*, a tiny plant with violet starry cups. It runs to 2 inches or so in height and to the ends of the rockery in breadth; but it is not too pushing and it associates nicely with smooth pearlwort (*Sagina glabra*) and most of the smaller thymes (*Thymus*).

The tussock bellflower (*C. carpatica*) is the king of the family and has been hybridized more than any other member. It makes a turf of 4-inch stems and throws up large lilac to violet goblets (also white and whitish ones), usually one to a stem, though some newer hybrids have more. A patch of any type growing well makes a bold and unforgettable sight—so bold, indeed, that it is wiser to treat *C. carpatica* as a dot plant rather than to lose its forceful effect by growing it in a mass.

McFarland

Campanula carpatica turbinata

More Difficult

Plants similar to *C. carpatica* are *C. carpatica turbinata* and *C. stansfieldi*, both smaller and a little harder to grow, but equally effective. Other plants that fall between "easy-to-grow" and "hard-to-grow" are those similar to *C. poscharskyana*: *C. elatines fenestrellata*, *C. elatines istriaca*, and *C. elatines garganica*. The last-named is so small and its color has such a strong touch of blue that it is worth growing in addition to Poscharsky—but not beside him, or it will disappear in record time. Its best form is W. H. PAINE, which has deep stars with a bright eye. This is easy enough to bring into flower but seems impossible to keep through the winter. It may be worth while to experiment with sharply drained conditions; but it may be that the plant is biennial—a fault that afflicts many of the choicer species.

J. G. Bacher courtesy

Campanula zoysi has pale blue flowers

Again, Very Difficult

Other hard-to-grow types, which the novice avoids and the expert welcomes, are the Swiss bellflower (*C. cenisia*), a gentle downy plant with rare violet bells; *C. wocki*, which looks like a hedgehog; *C. waldsteiniana* and *C. tommasiniana*, which are hard to distinguish; and among the hardest and choicest, *C. piperi* and *C. zoysi*.

In growing campanulas of any type, it is important to know that their popularity extends beyond the gardening fraternity. Slugs of all kinds esteem them highly, except the large yellow ones which are said to be carnivorous and cannibal. The remedy lies in a firm hand and also, it is said, in growing the choicer plants in masses as large as ever possible.

Stem cuttings. Left, *Aubrieta;* right, *Gypsophila repens.*

PROPAGATION OF ROCK GARDEN PLANTS BY CUTTINGS

To increase the numbers of rare kinds or kinds that do not come true from seed. When and how to make the cuttings and how to care for them. Stem, root, and leaf cuttings, with list of plants for each kind

D. C. Kiplinger

A GREAT number of rock garden plants can be propagated by cuttings; and this method of propagation offers the gardener a convenient means of increasing the population of particularly choice specimens. A cutting is a portion of a plant from which a new plant can be grown, after it is severed from the parent. Although stem cuttings are the commonest means of propagating herbaceous perennials, root cuttings or even leaves in a few cases may be an excellent way to increase the number of certain plants.

Stem Cuttings

The varied nature of rock garden plants makes it impossible to be very specific on exact procedures to be followed. Most stems are above ground; but in a few plants a portion of the stem may be underground and this underground part usually roots readily.

The time of the year when stem cuttings may be taken depends upon the kind of plant. One should avoid the very soft, succulent, watery tissue that is characteristic of the growth of many plants in early spring. This kind of growth is so soft that it will rot or wilt excessively and die despite all efforts to maintain a satisfactory environment. Very hard wood usually will not root; and so this, too, should be avoided. With many plants the right time for taking cuttings is when the stem snaps or breaks off clean if it is bent over. For short-growing plants such as many rock garden types, this rule of thumb is valueless because of the limited length of stem.

A sharp knife or razor blade should be used to remove the stem cuttings from the plant.

Placing cuttings in water delays certain healing processes and hence is not desirable unless the cuttings wilt excessively; a momentary dip is harmless, however.

The length of the cutting depends upon the type of plant. Cuttings longer than 4 or 5 inches may have so many leaves that wilting will be excessive; in such cases a shorter length is advantageous. With plants that grow compactly, possessing many crowns, each crown may be severed from the main plant with a short length of stem.

Lower leaves are generally removed to facilitate sticking the cuttings into the rooting medium. Leaves of many plants may safely be stripped off with the fingers; but with other plants a knife or razor blade must be used, to avoid tearing the stem or otherwise injuring it. As small a stub as possible should be left when leaves are removed.

Growth substances, or rooting hormones, may or may not be used, depending upon individual choice. In most plants treatment with growth substances causes a decided reduction in the time required for the cutting to root. The type of plant that normally will not root from cuttings when untreated must not be expected to root when treated with a hormone. These rooting hormones are aids, not cure-alls. Growth substances are available in liquid and in powder form; the latter is more easily used. The basal end of the cutting is dusted lightly with the powder and then stuck into the rooting medium.

Sharp sand is a rooting medium that has been used successfully for years. Trouble may be encountered with fine sand or sand that is contaminated with silt or clay. The fine particles retain excessive amounts of water and impede drainage, thus favoring the development of rot organisms which will attack the cuttings.

Sand and acid peat are sometimes mixed together in equal parts. This is a useful mixture for rooting cuttings of plants that grow best in an acid medium. Greater care must be exercised in watering this mixture than in watering clear sand, because of the high moisture-retaining capacity of the peat.

Vermiculite, or expanded mica, is quite satisfactory if it is not watered too much. Unlike sand, vermiculite does not become lighter in color when it dries; therefore it is often difficult to know whether to water it or not. Some gardeners use vermiculite exclusively, while others have given up in disgust. Because of its air- and water-holding capacity, vermiculite is an excellent rooting medium when properly handled. Other mediums may be used, but those mentioned here are the commonest.

Insertion. The rooting medium should be watered thoroughly, until it is well firmed, before the cuttings are stuck into it. Then an old knife should be inserted several inches deep into the medium, and a line drawn with it. Along this line the cuttings should be stuck into the medium to a depth of 1/3 to 1/2 their length. The next step is very important—the cuttings must be watered thoroughly, so that the particles of the rooting medium settle around the stems and prevent their drying. Since a cutting has no roots, it can absorb very little water; therefore close contact of the rooting medium with the stem is essential, but pounding the medium around the cuttings with a mallet and board does more harm than good.

Containers. So far nothing has been said about where the cuttings are stuck. For one who is fortunate enough to have a cold frame or hotbed, the problem is solved. Most gardeners must resort to some makeshift means, using shallow pots, cigar boxes, or crates, as containers for the rooting medium. Any depth between 3 and 6 inches is sufficient, but the container should be well drained. Small cracks swell shut when wood becomes wet, and seal off the escape of water.

Protection from sun and wind is all-important for the rooting of cuttings. A cold frame may have sash placed over the top, with burlap or lath slats to reduce the light intensity and the temperature inside. The north side of a house or the shade of a tree helps; and a cloth enclosure aids materially in reducing water loss from the cuttings under outdoor exposure.

Watering of the medium is the most troublesome operation because there are no rules to go by. If the medium seems to be beginning to dry out, it should be watered; but it must not be watered so often that only water-lilies could survive. Some enthusiasts use a constant water level with good results: a water table is maintained about 6 inches below the surface of the rooting medium; the water rises by capillarity and keeps the medium uniformly moist. If the water level is too high or the cuttings stuck too deep, rot quickly ruins the cuttings. A drain hole at the proper place prevents a good deal of trouble.

The time required for rooting varies; cuttings of some plants root in two weeks; others take as much as six or even eight weeks. Once rooted, the cuttings may be placed in small pots or planted in soil in the garden. Some protection should be given until they are well established; above all, they must not be allowed to suffer for lack of water.

Propagated by Stem Cuttings

madwort, including golden-tuft	*Alyssum*
rock-cress	*Arabis*
bearberry	*Arctostaphylos*
sandwort	*Arenaria*
wormwood	*Artemisia*
rock aster	*Aster alpinus*
aubrieta	*Aubrieta*
poppy-mallow	*Callirhoe*
bellflower	*Campanula*
ceanothus	*Ceanothus*
chrysanthemum	*Chrysanthemum*
bindweed	*Convolvulus*
daphne	*Daphne*
pink	*Dianthus*
bleeding-heart	*Dicentra*
wintergreen	*Gaultheria*
broom	*Genista*
gentian	*Gentiana*
avens	*Geum*
gypsophila	*Gypsophila*
sun-rose	*Helianthemum*
alum-root	*Heuchera*
St. Johnswort	*Hypericum*
candytuft	*Iberis*
gromwell	*Lithospermum*
forget-me-not	*Myosotis*
nepeta	*Nepeta*
moss-pink	*Phlox subulata*
primrose	*Primula*
lavender-cotton	*Santolina*
soapwort	*Saponaria*
saxifrage	*Saxifraga*
stonecrop	*Sedum*
thyme	*Thymus*
speedwell	*Veronica*
violet	*Viola*

Leaf Cuttings

There are few hardy herbaceous pere nials that can be propagated by leaf cu tings. These cuttings are handled in muc the same fashion as stem cuttings, but takes a considerable amount of time fo a new plant to form.

Propagated by Leaf Cuttings

cotyledon	*Cotyledon*
stonecrop	*Sedum*
houseleek	*Sempervivum*

Root Cuttings

These can be used successfully for som rock garden plants. Cuttings may b taken in the early spring, or in the fa after cool weather slows down growt

If the plant exhibits a dormant period in the summer, root cuttings may be taken at that time.

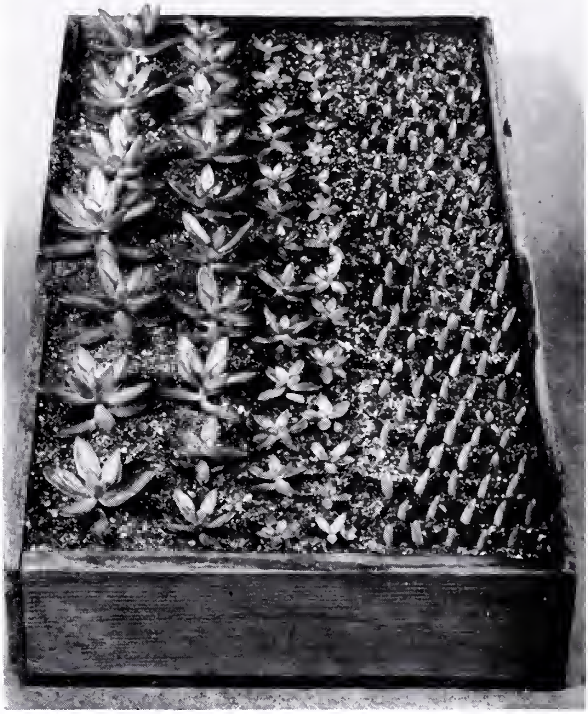
The plant should be dug carefully, so that the roots are not broken; then the medium-sized roots should be cut into pieces about 1¼ inches long. Many people believe that root cuttings must be stuck into the medium top end up, with the upper end at or slightly above the surface of the medium. While it is true that roots will form new plants if handled in this way, they may be also laid on their sides; and it is much easier not to have to remember which is the top end of a root.

A light soil mixture is a satisfactory medium. The root pieces should be laid end to end in a trench about ½ inch deep or less, covered with sand or the light soil mixture, watered thoroughly, and placed in the shade.

Not only must new roots form, but also new shoots; this may take as long as two or three months, depending on the kind of plant and on the temperature. When the new plant has several leaves, it may be removed carefully and either potted or planted out in the garden. Watering at this stage is extremely important.

PROPAGATED BY ROOT CUTTINGS

alkanet, or bugloss	*Anchusa*
anemone	*Anemone*
ceratostigma	*Ceratostigma*
bleeding-heart	*Dicentra*
shooting-star	*Dodecatheon*
cranesbill	*Geranium*
evening-primrose and sundrop	*Oenothera*
globe-flower	*Trollius*



Stonecrop (*Sedum*): *left,* stem cuttings; *right,* leaf cuttings.

J. G. Bacher courtes

Ramonda

GERMINATION AND GROWTH OF CERTAIN ROCK GARDEN PLANTS*

Why they are difficult to raise from seed and what can be done to bring about greater success

Lela V. Barton

IN RECENT years there has been a growing consciousness of the beauty and desirability of rock gardens, and with it an increase in the number of requests for information that is more accurate than the usual "trial and failure" method of cultivation.

It is evident that although plants may be classified as rock garden or alpine plants, their treatment cannot be similarly unified. The genera vary greatly in their requirements for germination, as do also the different species of any one genus. This variation is the fundamental basis o the difficulties encountered by growers.

In addition to this natural variatio among different kinds of plants, there ar numerous other causes of trouble in raising rock plants. Much of the difficult comes from having seeds that are empt or not viable. Some seed lots are mixture of two or more species and thus give germination results that are not dependabl Many of the seeds are very small and ar easily lost unless great care is taken. Different lots of seed of the same species often respond differently to the same treatment; this may be due to difference in ag of the plants from which the seeds ar collected or to difference in degree of maturity of the seeds at the time of collection. Seeds of rock garden plants are ver

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*This article is based on work done by the author and Eltora M. Schroeder, and described more fully—with tables and references to other articles on the subject—in *Contributions of the Boyce Thompson Institute*, vol. 10, p. 235.

sensitive to moisture; they usually require plenty of moisture, but good drainage must be provided. Sudden changes in atmospheric conditions easily upset the moisture balance; and since the seeds are planted very close to the surface of the soil, the roots are readily affected. Soil richness and texture, as well as acidity, are other conditions that affect seedling production.

Some seeds, of which Mariposa-lily (*Calochortus macrocarpus*) and bitter-root (*Lewisia rediviva*) are examples, germinate only at low temperatures. Others, such as those of the Welsh-poppy (*Meconopsis cambrica*) will germinate at ordinary temperatures, but only if they have had low temperature pretreatment (i.e., only if they have been exposed to low temperatures for about two months beforehand). Those of still another group—bellflowers (*Campanula*), St. Johnswort (*Hypericum*), and others — germinate readily over a wide temperature range. The germination of some seeds is influenced by their sensitivity to light: examples are some of the primroses (*Primula*) and the monkey-flower (*Mimulus guttatus*).

The specific treatments required for the germination of seventeen species of rock garden and alpine seeds are given here. These plants have been among the trouble makers.

Numerous tests made on seeds in lots of 100 (or occasionally only 50) are the basis of the generalizations and recommendations given here. Tests on planting seeds at different times of the year serve a double purpose: (1) to determine the best time for planting, and (2) to test the vitality of the seeds after different lengths of time in storage. The plants are grouped according to their responses to the various tests made.

Seeds that Germinate Easily

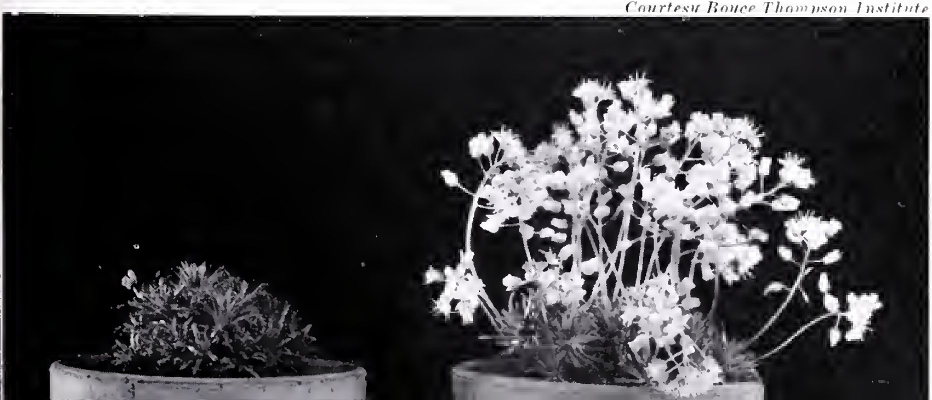
The first group consists of those seeds that germinate easily over a rather wide range of temperatures. The bearded bellflower (*Campanula barbata*), *C. elatines garganica*, and St. Johnswort (*Hypericum coris*) are in this class. Seeds of the bearded bellflower germinate very readily and within two weeks after being planted, at all temperatures from near freezing to ordinary outdoor summer temperatures in the New York area. The response at the lower temperatures is not quite so prompt, even though the final germination is as good as at the higher temperatures.

If started in December or January, the seeds of the bearded bellflower may be planted in a greenhouse; in the spring or fall they may be planted either in a greenhouse or in a board-covered cold frame. Plantings made in March, April, or September give better germination in a board-covered frame than in a greenhouse, and lose very little vitality even after eleven months of storage. Plantings made in October or in February give about the same germination in a greenhouse as in a cold frame.

Seeds of *C. elatines garganica* also germinate easily, but the range of favorable temperatures is not quite so wide as for *C. barbata*. In a greenhouse, results are likely to be variable, probably because these seedlings are very susceptible to damping off.

Seedlings of *Draba aizoides*. Left, after a winter in a greenhouse, unheated but never with a temperature below 40° F. Right, after a winter in an open cold frame.

Courtesy Boyce Thompson Institute



Fresh seeds of *Hypericum coris* respond in the same manner and with about the same speed as the bellflower seeds.

Gilia beard-tongue (*Penstemon ambiguus*) and silver-dust primrose (*Primula pulverulenta*) also germinate readily, but less so in a greenhouse. Work with twelve different kinds of beard-tongue (species of *Penstemon*) indicates that these seeds require a relatively low temperature (not higher than 68° F.) for germination. This explains the failure of these seeds to germinate when planted later in the spring.

None of the species mentioned so far are light sensitive; and none give any better germination after pretreatment at low temperatures (33° to 50° F.).

Seeds Affected by Light

Seeds in the second group exhibit a response to light. *Draba aizoides*, *Gentiana septemfida lagodechiana*, monkey-flower (*Mimulus guttatus*), and Himalayan primrose (*Primula denticulata*) do not require light for germination; but exposure to light permits germination at temperatures ordinarily too high (about 68° to 77° F.). The top primrose (*P. obconica*) and *Ramonda pyrenaica,* on the other hand, require light for germination. They germinate well at room temperature if allowed daylight, but not at all if kept in darkness.

Pretreatment at low temperature (about freezing) increases the germination at unfavorably high temperatures for the gentian but does not take the place of light in bringing about germination of the primrose and *Ramonda*. When seeds are planted in a greenhouse, the covering of sand is ordinarily not deep enough to prevent light from reaching them.

Dormant Seeds

This group consists of those species whose seeds are dormant and require low temperature pretreatment for germination: *Draba alpina* and Welsh-poppy (*Meconopsis cambrica*). These seeds germinate scarcely at all if planted at ordinary temperatures without first being exposed to low temperatures. In regions where winter temperatures are as low as 40° F., the easiest way to give low temperature pretreatment is to plant the seeds in cold frames in the fall and keep them there over winter. Good stands of seedlings will appear the following spring

Seeds Requiring Low Temperature for Germination

Seeds of green-banded Mariposa-lily (*Calochortus macrocarpus*), camass (*Camassia leichtlini*), and bitter-root (*Lewisia rediviva*) germinate well at 41° F within two to three months after being planted. This low temperature is necessary for germination and not for breaking dormancy—not merely as a pretreatment The seeds must be kept at this low temperature until they germinate. Plantings should therefore be made two or three months before the arrival of warm weather. Although either a mulched or a board covered cold frame furnishes favorable conditions for germination, the latter is to be preferred in the region of New York City, since the seedlings are likely to develop before the removal of the mulch in the spring—and so be lost. The temperature is right for germination of this group of seeds about the time the snow melts this may be what has given rise to the erroneous idea that snow water is necessary for their germination.

Growth of Plants Beyond the Seedling Stage

To eliminate injury from frequen transplanting, the tiny seedling plant may well be potted directly in 2¼-inc pots in a mixture of equal parts of sand sterilized leaf mold, and sterilized sod soi When repotting into 3½-inch or large pots is done, a mixture of cow manure leaf mold, and sterilized soil in equa parts may be used.

The most favorable conditions for late growth and blooming vary considerabl for the different plants. Some species d better at higher temperatures, others a lower temperatures. The illustration show that *Draba aizoides* flowers better in th spring if allowed winter temperatures be low 40° F. (page 263).

CONTROL OF PESTS IN THE ROCK GARDEN

Descriptions of eighteen kinds of unwelcome visitors, and methods of discouraging them

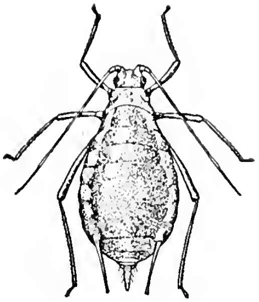
Ralph H. Davidson

ROCK garden plants are often attacked by a number of pests, the majority of which are insects. Some of these pests may cause severe damage if they are not checked. Those that are usually the most troublesome are briefly described here and the control measures given.

Aphids are small, soft-bodied individuals, usually green but often pink or sometimes black, depending on the species. They pierce all parts of the plant and suck the juices from them, causing stunting, curling, and wilting. Both wingless and winged individuals are often found.

Control. Spray with a solution of nicotine sulfate, 2 teaspoonfuls to a gallon of water in which 5 level teaspoonfuls of powdered soap have been dissolved. Commercial rotenone or pyrethrum emulsifiable preparations also are effective. Follow the directions on the container and be sure to wet the aphids with the spray. Either a 1 per cent gamma isomer dust of lindane, or a spray consisting of 1½ level tablespoonfuls of 25 per cent lindane wettable powder in 1½ gallons of water will also give control.

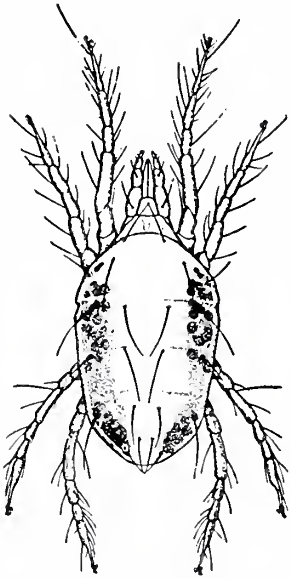
Red spiders have been more recently called two-spotted spider mites. They are very tiny eight-legged individuals, difficult to see without magnification, usually a pale greenish color with two dark brown spots on the back. Some reddish individuals occur, but these are fewer in number. Both young and adults suck plant sap, causing the appearance of very tiny grayish spots on the leaves. If very abundant they may kill the plant.



Aphid

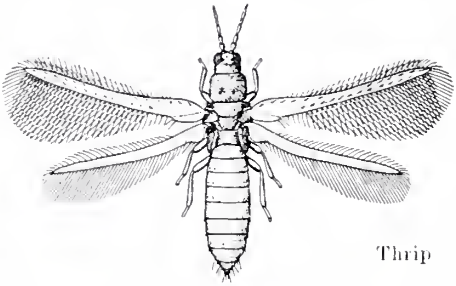
(This and most of the other drawings in this article are several times natural size.)

Control. Several effective commercial miticides (mite-killers) are now available: Ovotran, Aramite, Dimite, EPN, and Parathion. These should be used according to the manufacturers' directions. All safety precautions should be taken in handling them—especially EPN and Parathion, which are highly toxic to man and other animals. Dusting sulfur has miticidal properties, especially during hot weather. Rotenone emulsifiable concentrates diluted with water according to the manufacturers' recommendations



Red spider

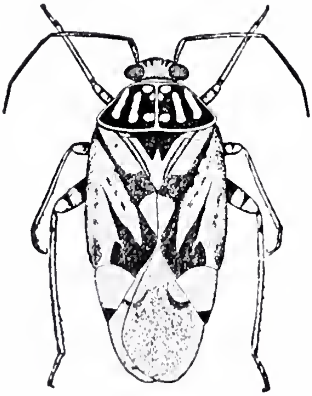
are effective if they come into direct contact with the mites.



Thrip

Thrips are very tiny insects which rasp the plant tissues and suck the exuding sap, causing small silvery spots on the leaves. The adults are usually brown, with slender wings fringed with hairs; the young are white and wingless.

Control. Use a spray made of 2 level tablespoonfuls of 50 per cent wettable DDT powder, or 50 per cent wettable chlordane powder, or 1½ level tablespoonfuls of 25 per cent gamma lindane, per gallon of water. If dusting is preferred, use a 5 per cent chlordane or DDT dust, or a 1 per cent gamma lindane dust.

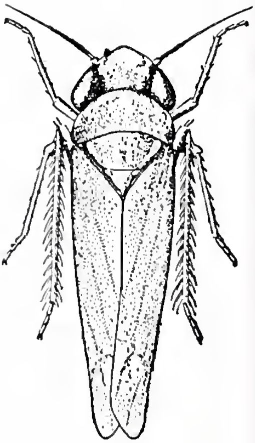


Plant bug

Plant bugs. Several kinds may be present, the commonest being the tarnished, the rapid, and the phlox plant bugs. They all cause stunting, curling, and distortion of the foliage by sucking plant sap.

Control. Apply 5 per cent DDT or 5 per cent chlordane dust. For spraying use DDT or chlordane as given for controlling thrips.

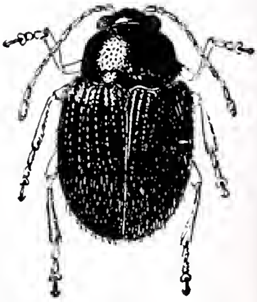
Leaf hoppers are small, slender insects usually $^{1}/_{8}$ inch or less in length. There are many kinds; they vary in color from brown to pale green, and some are spotted or striped. Injury is evident by the curling, distortion, and stunting of tender growing tips; with some kinds of leaf hoppers on some plants, a browning of leaf edges is characteristic, or the appearance of tiny, silvery spots. Some of these insects transmit the organisms causing diseases.



Leaf hopper

Control. Spray or dust with DDT as indicated for thrips.

Flea beetles are general feeders and are frequently found on the foliage of garden plants. As adults they eat small holes through the leaves, while the larvae of many species feed on the roots.

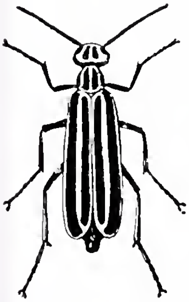


Flea beetle

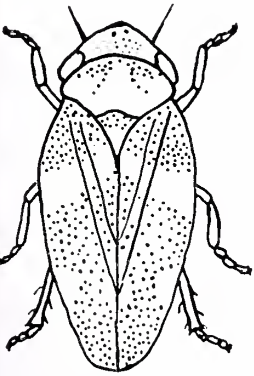
The adult has well developed hind legs and jumps about like a flea when disturbed. A number of different species are found in gardens.

Control. Use 5 per cent DDT dust or 0.75 per cent rotenone dust. Make repeated applications during the period of adult abundance.

Blister beetles chew and devour the foliage and flowers of plants. They are usually about ¾ inch long, slender, and colored either black or gray, or striped with brown and yellow.


Blister beetle

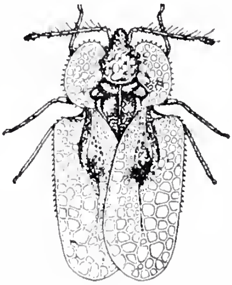
Control. Use DDT as given for control of thrips or use cryolite as a spray at the rate of 3 level tablespoonfuls per gallon of water. A cryolite dust may be made by mixing 2 parts cryolite with 1 part talc, tobacco dust, or cheap flour.


Spittle bug

Spittle bugs are becoming more widespread and may cause damage to perennial garden flowers, especially when the garden is adjacent to uncultivated areas. The adults are about ¼ inch long and mottled in color, and resemble robust leaf hoppers. The nymphs, or young, are evident usually during the month of May, inside frothy spittle masses on the tender growing tips of plants. They suck the plant sap and cause stunting and distortion. Adults are present usually from June to October.

Control. The adults may be controlled with DDT as given for thrips. The nymphs are killed by applications of 1 per cent gamma isomer dust of benzene hexachloride or 5 per cent chlordane dust or 10 per cent toxaphene dust. These treatments should be made after the overwintering eggs hatch, which is usually the last of April or early May.

Lace bugs. There are several kinds, some common species occurring on azaleas, chrysanthemums, and rhododendrons. The adults are flattened in appearance, with lacelike wings; the young are spiny. Both young and adults suck plant sap from the under surface of the leaves, causing a mottled grayish appearance of the upper surface.


Lace bug

Control. Apply DDT as given for controlling thrips.

Iris borer. The larvae injure the crowns and roots of iris by boring and tunneling with their chewing mouth parts. The insect overwinters in the egg stage, and the eggs hatch in the spring when new growth appears. The adult is a moth.

Control. Keep new growth in the spring covered with DDT or chlordane dusts or sprays as given for controlling thrips, or use lead arsenate spray consisting of 3 level tablespoonfuls per gallon of water.

Ants are frequently annoying in the rock garden. Some of them damage plants by nesting among the roots and exposing these to the air; others are injurious indirectly by their habit of caring for aphid colonies, root aphids especially. Some ants are attracted to plants that have sweet secretions, such as peonies (in their flower buds).

Control. Dusting the infested area with 5 per cent chlordane dust or 3 per cent heptachlor dust will easily eliminate the ants.

Grasshoppers. Several different species of grasshoppers may be found feeding on the foliage, flowers, and tender growth during the summer months. They usually migrate into gardens from adjacent grassy fields or vacant lots.

Control. Apply 5 per cent chlordane dust, or 10 per cent toxaphene dust to the garden and adjacent infested areas while the grasshoppers are still small in size.

Boxwood leaf miner. The adult is a very small fly. The yellowish larvae feed inside the leaves of boxwood, producing blotches or blisters on the lower surface. When abundant, they disfigure the plant by killing the leaves. The adults emerge in the spring and deposit eggs in the leaves. The time of emergence is dependent on the season and on the latitude of the region in question; for southern Ohio it is usually during the first two weeks of May.

Control. Successful control depends on making the insecticide applications during the period of adult emergence and killing these before eggs are deposited. Keep the foliage covered during this period with a 5 per cent DDT dust or a spray consisting of 2 level tablespoonfuls of 50 per cent DDT wettable powder to a gallon of water.

Slugs are injurious especially in damp and shaded places. They feed at night, eating large ragged holes in the leaves or completely devouring young seedlings They are soft slimy creatures, varying i color from black or brown to gray, wit a forked process on the head. A slu resembles a snail without a shell.

Slug

Control. The commercially prepare metaldehyde baits are quite satisfactory Anyone who wishes to prepare his ow may mix the following materials together:

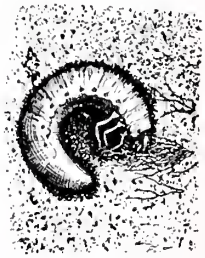
Metaldehyde, ½ ounce
Calcium arsenate, 1 ounce
Bran, 1 pound
Molasses, 2 teaspoonfuls
Water, 1 pint

Scatter the bait on the ground near th plants that are showing damage; do thi in the evening, since most of the feedin is done at night.

Earthworms may become very abundant in soils high in organic matter. I some instances they may cause injur to the root systems of plants.

Control. If control is necessary, appl chlordane or DDT to the soil at the rat of about 4 ounces of 50 per cent wettabl powder in sufficient water to cover a area of 1000 square feet.

White grubs are the immature stage o May beetles, or "June bugs." They fee in the soil on the roots of many plant but are generally more abundant wher grass plants abound. These curved-bodied, white larvae have brown heads with the tip of the body gray in color



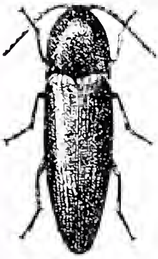
White Grub

The adults are rather large robust brown beetles, an inch or slightly more in length. It requires from one to three years to complete their life cycle, depending on the species.

Control. Use chlordane at the rate of ¼ to ½ pound of 50 per cent wettable powder in sufficient water to cover 1000 square feet of area. For dusting the same area, from 2½ to 5 pounds of 5 per cent dust will be required. Applications made before a heavy rainfall will be washed into the soil sufficiently to be effective. DDT may be used—double the amounts given for chlordane. Lindane also is effective and should be applied according to the manufacturer's directions.

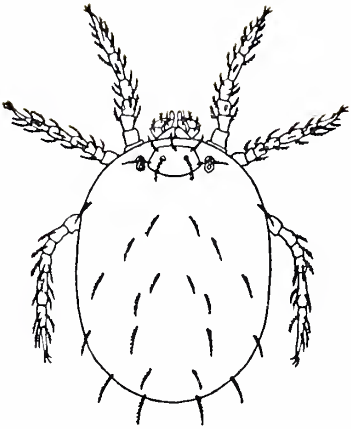
Wireworms are slender, cylindrical, smooth, brown larvae. When full-grown they are about an inch in length; they require from two to five years to develop to this size. They feed on the roots of all kinds of plants but are often more troublesome in grassy and damp areas. The adults are slender and brown, broader at the head and tapered toward the rear; they are known as **click beetles.**

Wireworm


Click beetle

Control the same as for white grubs.

Chiggers are very tiny mites which are difficult to see without some magnification. They do not feed on plants but cause a considerable amount of annoyance to persons visiting or working in the garden. Contrary to popular belief, chiggers do not burrow under the skin but only insert their mouth parts into the skin or into a hair follicle and begin feeding. The salivary secretion injected during feeding causes irritation accompanied by intense itching. Scratching these spots results in inflamed swollen blotches.


Chigger

Control. Infested areas should be treated with chlordane or lindane. Chlordane: use a pound of 5 per cent dust to 1000 square feet of area; or add 3 tablespoonfuls of a 45 per cent emulsion concentrate, or 6 level tablespoonfuls of 50 per cent wettable powder to enough water to cover 1000 square feet. Lindane: apply ½ pound of a 1 per cent dust to 1000 square feet of area; if other forms of lindane are used, follow the directions of the manufacturer.

If no area treatments are made, the use of dimethyl phthalate, dibutyl phthalate, or benzyl benzoate on the clothing and skin acts as a chigger repellent and effectively prevents their attaching themselves. Some of these materials are sold under trade names. In order to be sure what you are buying, look for the indicated ingredients on the label. Dusting sulfur applied to the clothing and the arms and legs also gives some protection but the odor is somewhat objectionable. Any of these materials must be applied before one goes into chigger-infested areas.

Philodendron mamei

WITHIN
THE BROOKLYN BOTANIC GARDEN

BLOSSOMING OF UNUSUAL TROPICAL PLANTS

Though the past summer's prolonged hot weather was very uncomfortable for many people, it was probably responsible for bringing into bloom certain plants in the greenhouses which had never (or rarely) flowered before.

A 70-year-old Cuban thatch palm, or seamberry palm (*Coccothrinax crinita*) bloomed in September. This plant has flowered but rarely in the thirty-seven years it has been in the Botanic Garden conservatory. The palm, now about 14 feet high, was given to the Garden i 1915 by John Lewis Childs, founder of th Flowerfield Bulb Farm, St. James, Lon Island. At that time it was the onl known living specimen of this plant i cultivation in the United States. Mr Childs obtained it from Cuba in 1894.

Though the individual flowers are ver small, they are borne in large, 3-foot clusters at the top of the plant. They are interesting rather than beautiful.

One of the less common species of *Phi*

Cuban thatch palm (*Coccothrinax crinita*). Arrow points to flower cluster.

odendron, P. mamei, which has large, arrow-shaped, spotted leaves, also bloomed in September. Though the flower is borne under the leaves, it is striking; it is about 7 inches long and resembles a calla-lily in shape. The leaflike spathe is dark red and the club-shaped spadix in the center is pure white. No complete description of the flower of this plant has yet been published.

The flower the Hawaiians use to make most of their leis also lent beauty to the greenhouses late in the summer. This is the famed frangipani (*Plumeria rubra*). Though the small tree has been growing in the greenhouse for many years, this is the first time it has flowered. The rose-pink flowers are 2½ inches across and are very fragrant.

Donald G. Huttleston

ANOTHER PLANT TO BE LABELED POISONOUS

Rhus trichocarpa, a rare tree from the Orient, grown principally for its orange o scarlet fall color, has now definitely been placed on the list of poisonous plants at the Brooklyn Botanic Garden. Tests during the past summer showed that juice from crushed foliage causes skin irritation and blistering similar to that produced by poison-ivy; contact with uncrushed foliage results in a slight chafing of the skin.

The poisonous characteristics of this plant are seldom mentioned in botanical literature, though it is sometimes described as being "probably poisonous."

The poisonous species of sumac are sometimes classified separately, as *Toxicodendron* instead of *Rhus*. Seeing *Rhus trichocarpa* called *Toxicodendron trichocarpum* was what prompted the tests.

James J. Franklin

AMONG THE CONTRIBUTORS TO THIS ISSUE

Lela V. Barton, Plant Physiologist and seed specialist at the Boyce Thompson Institute, Yonkers, New York.

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Freda J. Shoupp (Mrs. Harold) of Pleasant Hill, Ohio, amateur gardener and Contributing Editor of *The Garden Path*.

Virginia Stewart (Mrs. Coulter) of San Anselmo, California, California Chairma and an honorary vice-president of the American Rock Garden Society.

Alys Sutcliffe, a member of the staff of the Brooklyn Botanic Garden.

BACK ISSUES OF PLANTS AND GARDENS THAT ARE STILL AVAILABLE— EACH ONE A CLASSIC

Available at 60 cents each, except Spring, 1952, which is $1.50 (or $1 in lots of 100 for student use).

1946

Spring —Trees for Special Uses

1947

Autumn—Bulbs for Autumn Planting
Winter —Digest of Year's Best Garden Articles

1949

Summer—Lilies—Kinds and Culture
Autumn—Dwarf Trees and Shrubs
Winter —Digest of Year's Best Garden Articles

1950

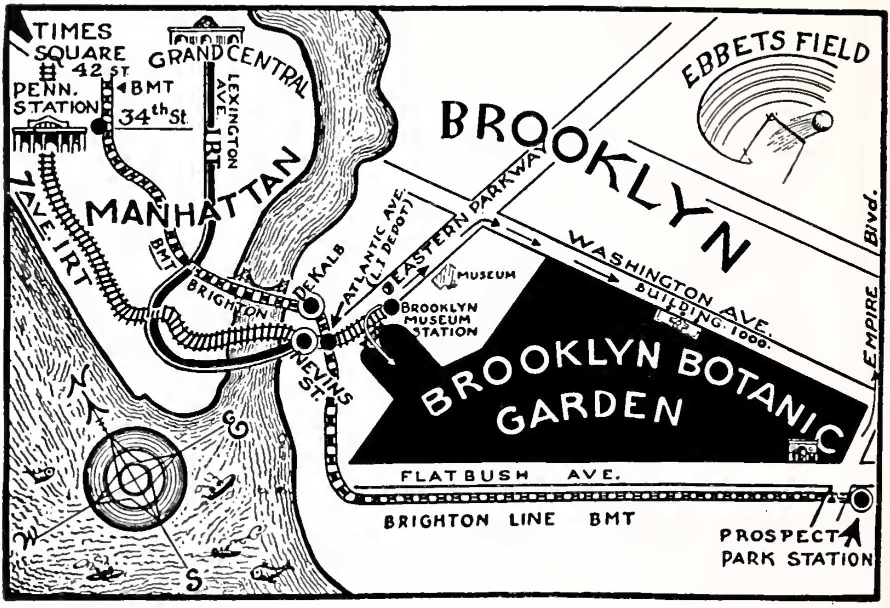
Spring —Flowering Trees
Summer—Poppies, Tree Peonies, and Lilies
Autumn—Herbs—Their History and Uses
Winter —Digest of Year's Best Garden Articles

1951

Spring —Flowering Shrubs
Summer—Garden Paths, Tree Diseases—96 pages
Autumn—Fruits for the Home Garden
Winter —Digest of Year's Best Garden Articles

1952

Spring —Plant Hormones, 112 pages
Summer—Pruning and Trimming



TO REACH THE GARDEN

By Subway

B.M.T., (Brighton Beach line) downtown express or local to Prospect Park Station.

I.R.T., West Side (7th Avenue or Broadway-7th Avenue line) downtown express marked "New Lots Avenue" or "Flatbush Avenue," to Eastern Parkway-Brooklyn Museum Station.

I.R.T., East Side (Lexington Avenue line) downtown express marked "New Lots Avenue" or "Utica Avenue" or "Atlantic Avenue," to Nevins Street; step across platform and change to 7th Avenue or Broadway-7th Avenue train, ride to Eastern Parkway-Brooklyn Museum Station.

By Bus

Flatbush Avenue bus to Empire Boulevard

Lorimer Street bus Tompkins Avenue bus	To Flatbush Avenue
Union Street bus Vanderbilt Avenue bus	To Prospect Park Plaza

By Automobile

From Long Island, take Eastern Parkway westward, and turn left at Washingto Avenue.

From Manhattan, take Manhattan Bridge, follow Flatbush Avenue Extension an Flatbush Avenue to Eastern Parkway; follow the Parkway to Washingto Avenue, then turn right.

BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

WINTER
1952-53

The
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in
Gardening
and
Horticulture

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Guide to
Recent
Nontechnical
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or Gardeners

NEW SERIES
. 8 NO. 4

AMONG THE CONTRIBUTORS TO THIS ISSUE

Douglas Baylis, professional Landscape Architect of San Francisco, California.

Olga Bockes (Mrs. William T.), amateur gardener and plant enthusiast, now establishing her own wild flower garden at Caldwell, New Jersey.

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John L. Creech, Horticulturist in Charge of the United States Department of Agriculture's Plant Introduction Garden at Glenn Dale, Maryland.

Geraldine Farrar, famed soprano of the Metropolitan Opera Company, now retired and living at Ridgefield, Connecticut.

Joan Lee Faust, a member of the staff, Brooklyn Botanic Garden.

Fred V. Grau, Director of the United States Golf Association Green Section, Beltsville, Maryland.

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Donald G. Huttleston, a member of the staff, Brooklyn Botanic Garden.

Harland Manchester of New York City, roving editor of the *Reader's Digest* and author of *New World Machines*.

G. G. Nearing, Editor of the *Bulletin of the American Rock Garden Society*, Ramsey, New Jersey.

F. F. Rockwell, Editor of *The Home Garden* and author of many gardening books and articles.

Freeman A. Weiss, Curator of the American Type Culture Collection Society, Washington, D. C., and former Plant Pathologist for the United States Department of Agriculture.

John C. Wister, former Editor of Plants & Gardens, and Director of the Arthur Hoyt Scott Foundation at Swarthmore College, Swarthmore, Pennsylvania.

PLANTS & GARDENS

Kerria japonica

VOL. 8 **Winter, 1952-53** NO. 4

CONTENTS

Cover: Winter Evening—Brooklyn Botanic Garden Administration Building

Page

Authors Whose Articles Appear in This Issue .... Page 2 of cover
Frontispiece 274
Director's Letter 275
Sharpen Your Lawn with These Edges .... *Better Homes & Gardens* 276
Better Grasses for Better Lawns .... *Flower Grower* 279
How to Make Plants Dwarf .... Joan Lee Faust 282
Krilium and Its Rivals .... *Harper's Magazine* 289
Stop, Thief! .... *Popular Gardening* 293
Know the Odds When You Gamble on Hardiness .... *The Home Garden* 295
Air Layering with Plastics .... *Popular Gardening* 298
Which Greenhouse for You? .... *The Home Garden* 301
What My Garden Means to Me .... *Horticulture* 304
Bring the Woods Indoors in Winter .... *Flower Grower* 306
Making a Bog Garden with Sphagnum .... *Bulletin of the American Rock Garden Society* 309
Evaluating the Flowering Crabs .... *American Nurserymen* 311
Eight Famous Plant Hunters .... Donald G. Huttleston 314
Crooked Trees Are Good .... *Landscape Architecture* 323
Selected List of Recent Nontechnical Books, Magazine Articles, and Experiment Station Bulletins 326
Within the Brooklyn Botanic Garden 331
Index to Volume 8 (with Corrections) 332

Drawings by PETER K. NELSON except where otherwise indicated

Editorial: CONRAD B. LINK, HESTER M. RUSK, JOAN LEE FAUST, and the Editorial Committee of the Brooklyn Botanic Garden

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NOTICE OF CHANGE OF ADDRESS AND ALL OTHER CORRESPONDENCE
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Soft snow brings decorative touch to border trellis of Cranford Rose Garden, in the Brooklyn Botanic Garden.

Except where otherwise credited, photographs by Louis Buhle

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BROOKLYN BOTANIC GARDEN
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TELEPHONE: MAIN 2-4433

Winter 1952-53

The Year in Review

In this issue of PLANTS & GARDENS our Editorial Committee presents its eighth annual selection of outstanding nontechnical articles on gardening and horticulture. In the collective judgment of our Committee, the articles chosen will be of lasting interest. We are proud to present them and thus honor the authors as well as the publishers of the magazines in which the articles first appeared.

The Botanic Garden has no Pulitzer Prize (or its equivalent) to award, but until the day comes that we do, it is a happy satisfaction to give special recognition where recognition is due.

The reading list may lead to articles, books and bulletins that might have been missed during the year.

Original Articles

The work of Dr. Karl Sax, Director of the Arnold Arboretum, is of outstanding interest. Many readers will want to try for themselves his methods of experimental dwarfing of plants by grafting.

"Plant Hunters" concerns pioneers in the field of plant exploration, and interesting plants they brought back to American gardens.

COMING - 1953	Topic	Guest Editor
Spring	Handbook for Gardeners	Alfred C. Hottes
Summer	Gardens for America	Mary Deputy Lamson
Autumn	Bonsai; Dwarf Trees as the Japanese Grow Them	Kan Yashiroda

Sincerely yours,

George S. Avery, Jr.

Director

Please Note:

Title page and contents of the 1952 volume will be sent to libraries for binding and will be available to individuals upon request.

Errors known to occur in this volume are corrected at the end of the index.

SHARPEN YOUR LAWN WITH THESE EDGES

Using bricks, boards, stone slabs, or concrete blocks

Douglas Baylis

Reprinted from *Better Homes & Gardens,* April, 1952

CRISP, clean edges around any home make it easier to care for, make it look better. Good edges between paths, lawn, flower beds, and areas with definite division lines add distinction to your whole plan.

Some edges eliminate hand trimming of lawn borders; others will hold gravel in walks; still others can be used to raise a flower bed above the rest of a garden. Some may do double duty by serving as emergency walks when the ground is wet.

Keep your edges simple. Novelty treatments like rows of bottles, saw-tooth brick borders, jagged edges of field stone, or rows of boulders are dangerous, often look bad, and cause extra work. It's also unwise to put rustic borders in a formal garden or use an excess of straight regular construction in an informal setting.

Here are some of many possibilities, all simple to make and easy to keep up:

If You Use Wood

Use decay-resistant wood for good results. Redwood or cypress is best for use on soil. Treat the wood with a rot-retarding chemical, either *copper naphthenate* or *pentachlorophenol.* Both can be applied with a brush.

If it's available where you live, you can use wood already treated to resist decay. It's safest not to set your plants against wood that's been chemically treated, the first season.

Make sure the wood you use is heavy enough to withstand knocks from lawn mowers and other tools without breaking or other damage.

Use stout stakes to anchor your wood edgings, and drive them deep into the ground. Use rustproof nails, and put the stakes on the side where they won't show.

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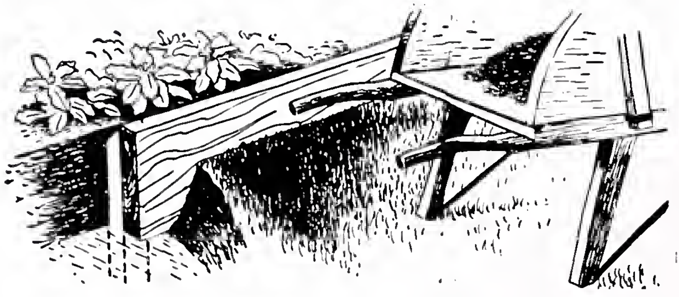
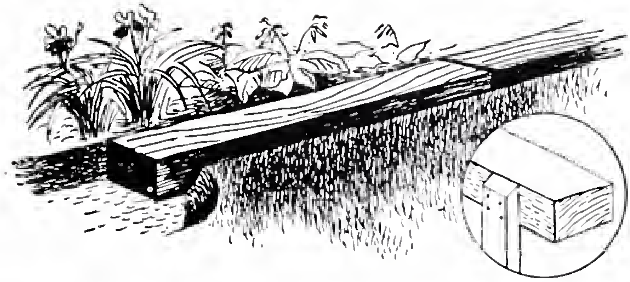
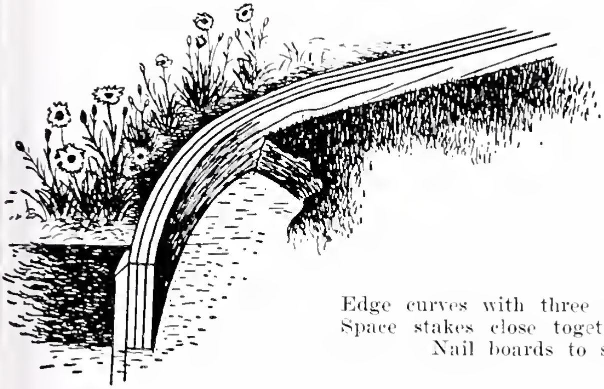


Drawings courtesy Better Homes & Garden

For a neat border use 2- x 6-inch boards, and for a raised bed 2- x 12-inch. Drive stout stakes deep in position. Cut stakes off below surface.

Use discarded railroad ties to make informal, mellow-looking borders. Hold them firmly with 2- x 4-inch stakes, 3 feet long, nailed as pictured.





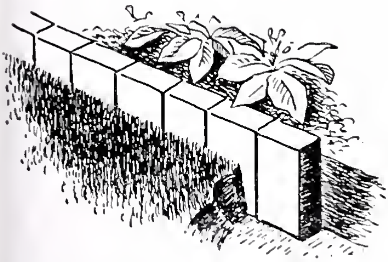
Edge curves with three thicknesses of $\frac{1}{2}$-inch boards. Space stakes close together to make the curve even. Nail boards to stakes one at a time.

If You Use Brick

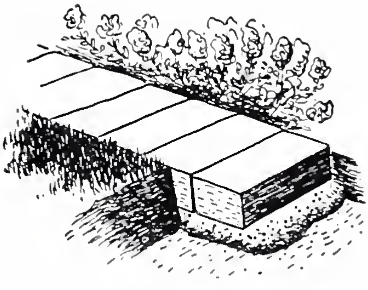
Get used brick if possible. Besides being cheaper, it looks right from the start.

Old mortar can be removed by scrubbing with muriatic acid solution. Dilute a pint of acid (from the drug-store) with a gallon of water. Add the acid to the water, not the reverse. Wear rubber gloves; apply with a fiber brush. Keep acid in glass or crockery container.

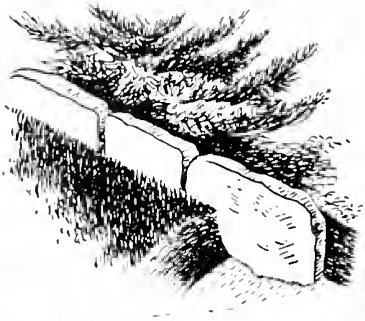
Brick mowing strips will be perfectly satisfactory if set on a bed of 2 inches or more of well tamped sand, with sand swept into the joints. Single-row brick edgings must be set deep enough to hold bricks firmly.



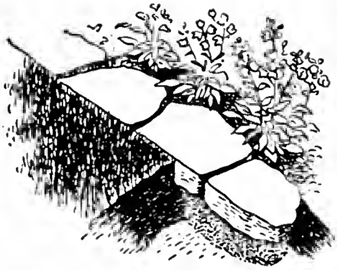
Set single row of bricks on end to make neat edge. Bury two thirds of each brick, so that edging will stay firmly in place.



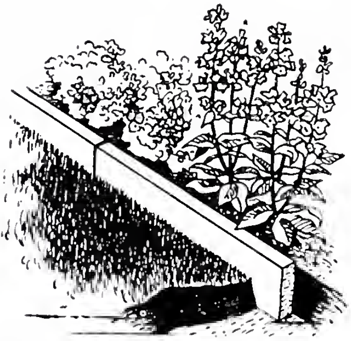
Brick mowing strip, one brick wide. Lay bricks on sand base. If strip is two bricks wide it makes an emergency path for wet weather.



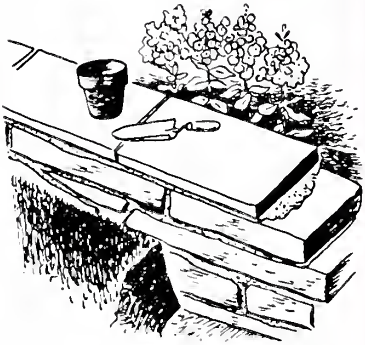
Set flat stones on edge, each two-thirds into soil, to make a sturdy, informal border. Use stones of equal thickness and keep top edges even.



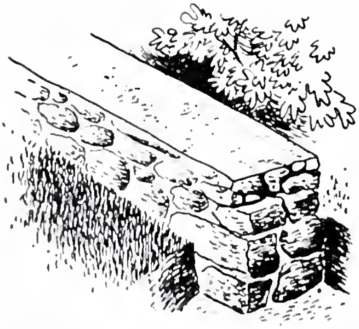
For mowing strip lay flat rocks. Keep edge on lawn side fairly straight. A sand base keeps rocks in place when ground is wet.



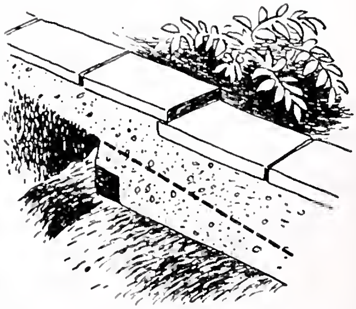
Concrete slabs on edge will hold a flower bed in place or edge a path of crushed rock. Precast the slabs yourself.



Border of ledge rock capped with slate also serves as a place to sit. Rocks can be laid in mortar if wall has good foundation.



Raised border, actually a low stone wall, made by laying stones in stiff mortar. Finish wall by leveling top with wash layer of thin mortar.



Raised border of concrete capped with slate. The one shown is on a slope, with top kept level in steps.

BETTER GRASSES FOR BETTER LAWNS

Although they may not be on the market for some time, they promise a bright future for home gardens

Fred V. Grau

Condensed from *Flower Grower*, March, 1952

THE outlook for lawns is good. Improved grasses are giving new hope to millions of people who have tried without success to grow first-class lawns. Until recently, building a good turf out of the available grasses was difficult in most cases and impossible in many.

The lawn of the future is the fairway of today. And so, although the grasses and turf practices discussed here were developed for golf, they are especially suited for producing lawns for those who want the best.

Blue Grass

Merion (B-27) blue grass is the newest and most exciting turf grass in the United States today. It is capable of producing the kind of turf that golfers and homeowners alike have dreamed about.

There is not yet enough seed to go around, even with the retail price of $5 a pound. Merion isn't one of the best seed-producing blue grasses; nor is it easy to establish in the great seed-producing areas of the Pacific Northwest. These limitations make it expensive to produce. The seed harvest in Oregon in June is demanded on the eastern market in August in time for fall planting. This requires special handling, and again costs rise.

Merion thrives under short cutting. No longer will you have to set the mower high (1½ to 2 inches) to *hold* blue grass, when the lawn is established to Merion. In fact, some of the worst disappointments I've seen with Merion came about because the lawns were mowed too high. We recommend a ¾-inch setting for home lawns, closer to ½ inch for fairways.

Merion is drought tolerant. I've seen it go nearly a month in Washington, D. C., without water and still stay in good condition. Merion is giving a good account of itself over the entire blue grass region and shows strong tendencies of going beyond those arbitrary limits.

Merion is crab grass resistant. One reason is that it is very resistant to leaf-spot disease which weakens common blue grass in the spring and opens the way for crab grass.

There isn't enough seed of Merion at present to encourage mixtures with other grasses. We're still recommending that Merion be considered by itself until we have more seed and more information. The national recommended rate of sowing Merion is a maximum of a pound to 1,000 square feet.

Merion needs generous feeding and it responds wonderfully because it has a well developed root system. When Merion is starved it may get dollarspot—then it's time to feed! Fertilizers with such formulas as 10-5-5, 10-6-4, 8-6-2, and 8-6-4 are well balanced for maintenance feeding of Merion. Fertilizers with high phosphorus contents, 4-12-4 or 5-10-5, are excellent for fertilizing seed beds.

We like to **feed when it needs it** and not worry too much about specific timing recommendations. About a pound of nitrogen to 1,000 square feet is the rate we

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like. This calls for 10 pounds of a 10 per cent nitrogen fertilizer or 20 pounds of a 5 per cent nitrogen fertilizer. The best plan is to consult your own state experiment station or your county agent for local recommendations.

Merion will respond to aerifying or the cultivating of soil beneath the turf. This modern practice is a *must* on golf courses and athletic fields and even on pastures. Lawns benefit greatly from this soil cultivation. It lets air, fertilizer, and water into the root zone, thus encouraging deeper root growth and insuring against drought damage.

Caution about Merion blue grass in relation to the use of crab grass killers containing *phenyl mercuric acetate*: results to date indicate that Merion and mercury don't agree too well. Our advice is to keep them apart until we know more about the situation. After Merion becomes established there shouldn't be much crab grass. But if a crab grass killer is needed the first season or two, we suggest *potassium cyanate* as the safest material.

Bermuda Grass

At Tifton, Georgia, Dr. Glenn Burton and his associates have been working on improved strains of Bermuda grass. Out of this program has come Tifton 57 Bermuda, which is now available at a few nurseries. Tifton 57 is a vigorous, disease-resistant strain which covers the so-called conversion period in the spring when rye grass dies. Tifton 57 pops back with a bang weeks ahead of common cotton-patch Bermuda.

One of the fascinating strains of Bermuda grass is the one known as U-3, a selection from Savannah, Georgia. This fine-bladed, cold-hardy strain has found favor within the northern limits of the southern grasses where Bermuda is not expected to survive. It is finding increasing use in such areas as New Jersey, Maryland, Virginia, Missouri, Kansas, Oklahoma, and California. U-3 is not one of the most popular grasses for lawns, because of the traditional dislike for wire grass. It requires close, frequent mowing and generous fertilization, but very little irrigation. The extra effort will rewar the man who builds a lawn out of U-3.

Zoysia

While we are on the subject of warm season grasses we must describe Meye (Z-52) zoysia, an improved type whic has been tested from coast to coast. Nex to Merion blue grass, it is probably th most talked-of grass in the country today. Its success under indifferent management has been little short of phenomenal from New England to California an from Miami to Michigan.

Planting stock is still in the form o sprigs or 2-inch living sod plugs, with n seed available commercially as yet. O 12-inch centers, these plugs form soli turf in two years and eliminate crab gras with no outside assistance. United State Golf Association Green Section researc shows that in poor, grub-infested soil plugs planted every two weeks throughout the year exhibited 96 per cent survival, with no supplemental irrigation o fertilization. This truly is foolproo planting.

Fescue and Bent Grass

The combined efforts of Professor H B. Musser and his staff at State Colleg Pennsylvania, a well-known seed growe on the West Coast, and the United State Golf Association Green Section have resulted in new proved strains of creepin red fescue which appear to be to th common red fescues what Merion blu grass is to Kentucky blue grass. Thes new fescues will be produced as a synthetic blend and should reach the marke in two to three years. Until then, w will continue to use Penn State Chewing fescue, Illahee creeping red fescue, an Oregon red creeper.

Bent grasses never have been popula for lawns, because they require a lot o work, are subject to various diseases whic the homeowner can't cope with, and usually look ratty when they should be a their best. Much improvement work o the bent grasses has been done by th USGA Green Section and by several stat experiment stations.

Penn State has come up with a poly

cross creeping bent seed which will be in heavy demand for golf courses. How it will fit into home lawns remains to be seen. Rhode Island has been working on improved types of colonial bents, and we may have something in that line for home lawns in a few years. Lawn mixtures with bent will still include Astoria, Highland, and New Zealand colonial bents. Seaside is rarely used in lawn mixtures.

Today, after nearly twenty-five years of research, crab grass has been removed from the No. 1 spot among the nation's turf weeds. Improved grasses, safe chemicals, aerifying machinery, better fertilizing knowledge, combs on mowers, and other factors have led to the downfall of crab grass.

Aerification

Since 1946 there has developed a dramatic change in turf management. The major change lies in our ability to cultivate soils under turf surfaces without spoiling the surface for play. When this can be done successfully on a putting green, one must admit that it can be done on nearly any kind of turf, lawns especially. Any golf course supply dealer can further explain this aerifying technique and furnish a machine to do it. Some nurserymen and landscape gardeners provide custom aerifying.

The best time to aerify lawns is in spring and fall when the amount of soil moisture is favorable for growth and easy cultivation. Fertilizer applied after aerifying gets deep into the root zone. Rainfall enters the soil instead of running off, consequently necessitates fewer watering periods, and irrigation water is saved.

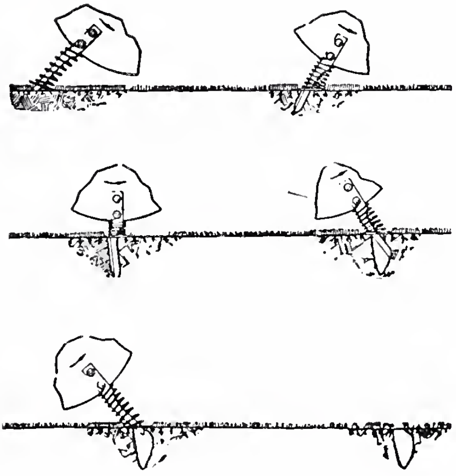
Tools of various sizes are available for any size turf area up to and including pastures. Aerifier holes make perfect pockets for foolproof seeding when introducing new grass into the existing turf. This little-known feature of aerifying alone has resulted in great savings of seed on many turf areas over the United States.

Everything so far points to the basic recommendation **"water when needed."** Much turf is overwatered and poorly watered. Too little would often be better than too much. Additional studies indicate greatly improved water penetration after cultivation.

West Point photo

Aerifying device. Diagrams below show how single spoon works.

A coil of wire about the half-round spoon keeps grass in place as spoon is inserted, tilted backward, and removed from the soil. A loose walled cavity is left below the turf.



West Point

In Short

Today, the homeowner can mow his lawn short, the way most of them want it, because the new improved grasses thrive under close mowing. Leaves are easier to remove from closely mowed turf and it is more enjoyable to gardeners.

The parade of better grasses for better turf has just begun. We can look forward to a steady flow of improvements in turf conditions.

Photos courtesy Arnold Arboretum
Karl Sax and his 5-year-old STANLEY plum, budded on Nanking cherry (*Prunus tomentosa*).

HOW TO MAKE PLANTS DWARF

From an interview with Dr. Karl Sax, Director of the Arnold Arboretum

Joan Lee Faust

CONTEMPORARY properties and homes are tending more and more to be moderate in size, as people nestle close to the large cities in suburban areas. Even in smaller towns, the problem of taking care of large places offers many difficulties; and the trend, therefore, is toward reducing the scale of horticultural projects around the home. Where space is limited, the use of dwarf plants makes it possible to grow many kinds instead of a few; and when more dwarf trees of common fruit varieties are available, a piece of land 30 or 40 feet square should be ample for producing the fruit needed for a family's use.

Background

For many years, horticulturists and others have been aware of the need for smaller plants in the home garden, and a considerable amount of progress ha been made in the use of low-growing an slow-growing shrubs and trees for plant ing the home grounds. These are *natur* dwarfs, such as some of the hemlock spruces, and white pines—small edition of the original large-growing specie Many nurserymen can supply them. N yet so common are *artificially* dwarfe ornamental or fruit-bearing plants; bu amateur gardeners and horticulturists a ready know that dwarf apple trees, o practically any kind, can be made b grafting scions of the desired variety o the famous English MALLING IX ro stock. (*Plants & Gardens,* 1951, page 176 to 179.)

Pot-grown ornamental dwarf trees an shrubs as the Japanese have grown the for centuries are becoming well know to occidental horticulture; trees th might become forest giants are dwarfe by root pruning and pot binding, and b pinching back and training the branche (*Plants & Gardens,* 1949, pages 149 t 153; 1950, pages 68 to 79 and 127 to 128.

History records artificial dwarfing as an art form in France as early as the seventeenth century; gardens were filled with curious plants dwarfed by certain horticultural practices. Thus, artificial dwarfing is not new, but there is still need for improvement; research can point the way.

Grafting, a long-established practice in fruit tree culture, is still the principal means of reproducing most fruit trees. It has long been known that some stocks used in grafting exert a dwarfing influence on the scions. In fact, stocks with dwarf-inducing characteristics have been used in Europe for apples and pears for 300 or 400 years.

Dr. Karl Sax, Director of the Arnold Arboretum, at Jamaica Plain, Massachusetts, is at present investigating artificial methods of dwarfing ornamental woody plants and fruit trees. He is reviewing and repeating practices known centuries ago to European horticulture, as well as contributing new methods of his own. The research is carried on with a small summer staff of collaborating graduate students, in a half-acre field laboratory just outside the doors of Harvard University's Bussey Institute.

Dwarfing Effects of Certain Root Stocks

The photographs on these two facing pages, and the one at the top of page 284 show a few examples of successful dwarfing accomplished at the Arboretum. The height and size of these trees simplify maintenance and care for the home gardener: it is easy to prune, spray, and harvest from them.

In addition to those pictured, other combinations have been found to give similar dwarfing effects.

Apples may be dwarfed by grafting on the Malling stocks, especially Nos. VIII and IX. Several varieties of apple may also be dwarfed by using Sargent's crab apple as the stock (*Malus sargenti*). McIntosh apples are partially dwarfed when grafted on Malling VII or on the Chinese crab apple (*Malus sikkimensis*).

Four-year-old Vestale lilac on tree lilac root stock. In spite of the fact that the root stock species ordinarily grows to be a large tree, it exerts a mild dwarfing influence on the scion variety and produces a *dwarf tree* that does not sucker. Jackson Dawson of Arnold Arboretum staff tried this fifty years ago; Dr. Sax is testing it again. Joan Lee Faust standing beside lilac.

Another, the Florentine crab apple (*Malus florentina*) is too strongly dwarfing in its effect and fails to survive cold winters.

Pear varieties are usually dwarfed by grafting on quince root stocks (*Cydonia*) but can also be dwarfed by grafting on cotoneaster (*C. multiflora*) and certain kinds of hawthorn (*Crataegus*); these root stocks have not yet been adequately tested.

Peaches and plums work well on Nanking cherry stock (*Prunus tomentosa*), and also on almond cherry (*P. glandulosa*), though the latter is apt to sucker badly. Peaches may be dwarfed by grafting on the sand cherry (*P. besseyi*), and sweet cherries on beach plum (*P. maritima*), although there is a considerable amount of overgrowth of the cherry scion.

The ornamental red chokeberry (*Aronia arbutifolia*), produces a dwarf plant when grafted on stock of the hawthorn *Crataegus pedicellata*.

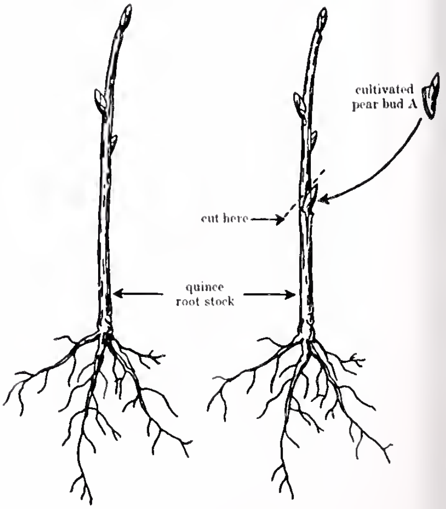
Five-year-old Early East peach budded on Nanking cherry (*Prunus tomentosa*); less than 5 feet tall, this tree bore fifty full-size peaches in its fifth year.

Double Working

In budding, it is sometimes found that the union between stock and scion will not heal or grow, a discouraging situation known as *incompatibility*. This could be a serious stumbling block, but one solution is the early horticultural practice called *double working*. Essentially, this involves the use of an interstock which will grow to (i.e., *be compatible with*) both the desired root stock and the desired scion varieties.

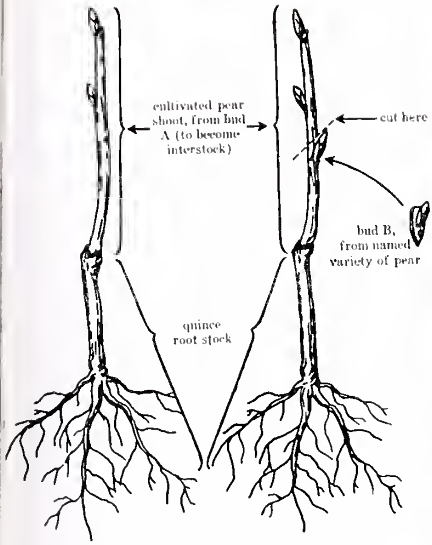
For example, quince will dwarf pears, but not all varieties of pear will grow on quince. A cultivated pear variety that is compatible both with quince and with the desired named variety of pear may be used as an interstock between the other two. The cultivated pear is budded on the quince root stock; and when this union is established, the named variety of pear is budded on the cultivated pear. The drawings illustrate the method.

Pear can be dwarfed by grafting on



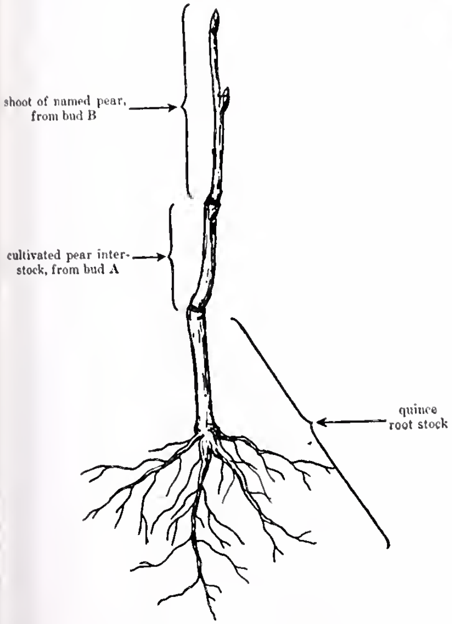
First step in double working.

FIRST YEAR: Insert bud of cultivated pear in quince root stock, late summer; wrap with rubber budding band. When this heals, cut off quince stem above pear bud, allowing bud to grow.


cultivated pear shoot, from bud A (to become interstock)
cut here
bud B, from named variety of pear
quince root stock

Second step in double working.

SECOND YEAR: Bud named variety of pear on cultivated pear interstock in late summer; bind with rubber budding band. When union is established, cut off cultivated pear interstock above bud.


shoot of named pear, from bud B
cultivated pear interstock, from bud A
quince root stock

THIRD YEAR: Young tree produced by double working.

Effect of double working: 3-year-old McIntosh apple in fruit. Interstock of Clark's Dwarf and root stock of Chinese crab apple. (Clark's Dwarf has been identified as Malling VIII by Karl Brase of the New York Agricultural Experiment Station.)

cotoneaster, but this root stock makes transplanting difficult, because cotoneaster has a weak root system. Double working, with an interstock of cotoneaster and a root stock of wild pear or hawthorn, preserves the dwarfing influence of cotoneaster but overcomes the transplanting difficulty.

The photograph above shows the effect of double working on apple.

Some adept propagators accomplish the double working process in one year. The interstock and scion are grafted, stored, and allowed to callus through the winter. In the spring, the callused top is grafted on a root stock growing in the greenhouse or in the field.

Propagation of Root Stocks

Multiplication of root stocks is generally done by layering or by cuttings. Both are expensive methods of propagation, involving much labor and care when stocks are needed in quantity. Karl Sax and his assistants have been working with three root stocks which will come true to seed. In addition to the apomictic Chinese crab apple* (*Malus sikkimensis*) and Sargent's crab apple (*M. sargenti*) two cherry stocks can be seeded, almond cherry (*Prunus glandulosa*) and Nanking cherry (*P. tomentosa*).

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*Apomictic refers to plants that produce seeds without pollen.

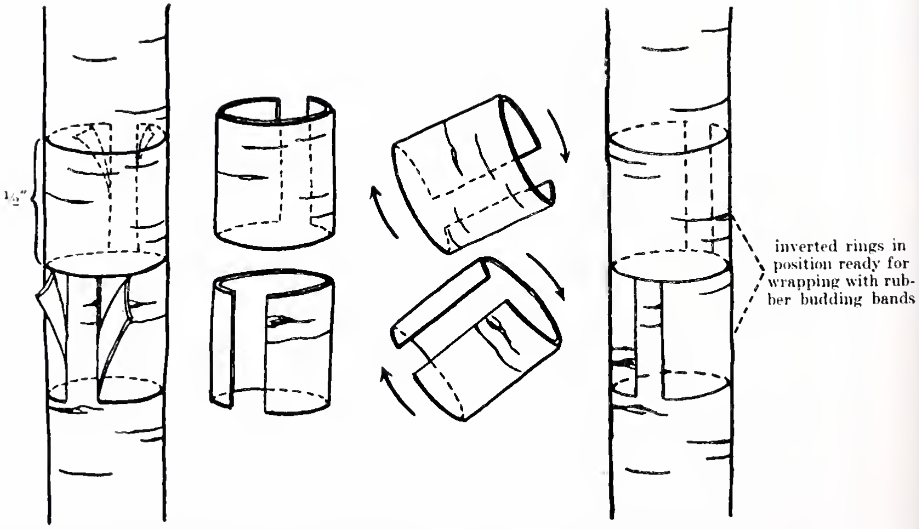
Inversion of Bark Ring

Another method of dwarfing which Dr. Sax has modified from an old-time practice involves merely the inversion of two half-inch rings of bark on a yearling tree. In late summer or early fall, the rings are cut one immediately above the other, near the base of the tree, with a narrow strip of normal bark remaining on opposite sides of the stem on the two rings. After the bark rings are inverted, they are wrapped with large-size rubber bands; within five to ten days the inverted rings heal (drawings below).

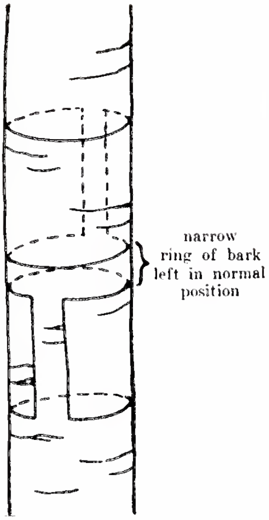
A variation of the first method is to leave a band of normal bark between the two inverted rings, as illustrated in the drawing on the opposite page.

Both of these experiments exert a dwarfing influence; but longer-term trials are necessary to determine how long the effect will last, and whether either method will turn out to be a desirable horticultural practice.

The photograph on the opposite page shows the result of inverting bark rings.


½"
inverted rings in position ready for wrapping with rubber budding bands

Cut two incomplete rings of bark, leaving narrow strips undisturbed on opposite sides of stem. Remove rings, turn them upside down, and place back on stem in inverted position; fasten tightly with rubber budding bands.



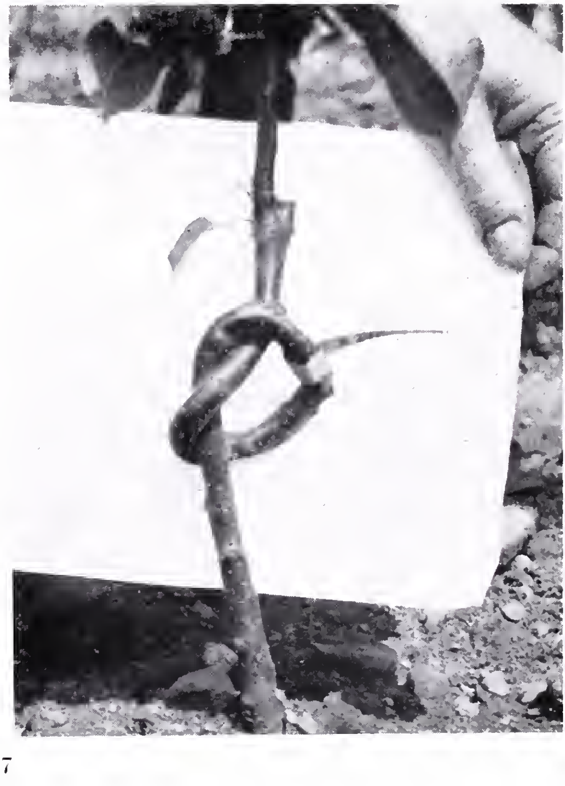
Modified method: as on opposite page, inverted rings in position, but with narrow ring of normal bark between the two inverted rings.

Four-year-old Cortland apple dwarfed by turning two short segments of its bark upside down.

Knotting

A very simple method of dwarfing is an adaptation of the French knot tying—as illustrated. A simple loop knot is tied in the whip of a young root stock in early summer. A few months later a named variety is budded above the knot.

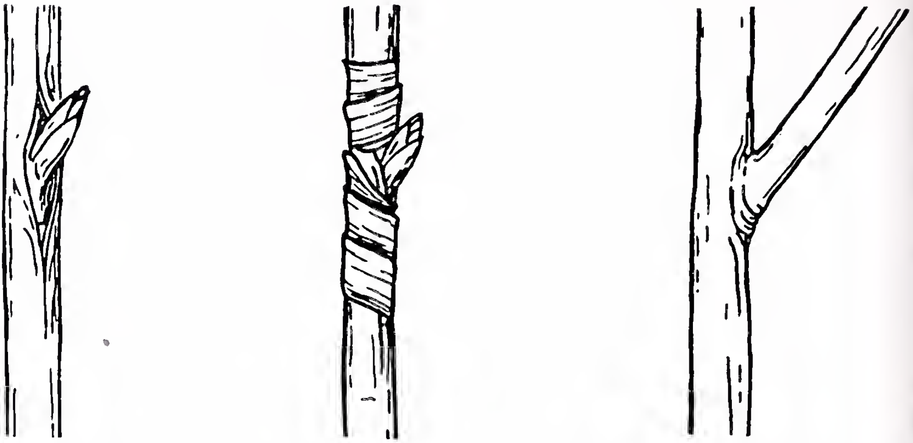
This method could be used with seedling shade trees and other ornamentals. The stems must be tough enough to tie but not so brittle that they break. The permanence of the knot-tying method of dwarfing is as yet undetermined, but for those who are experimentally inclined, it is worth trying.



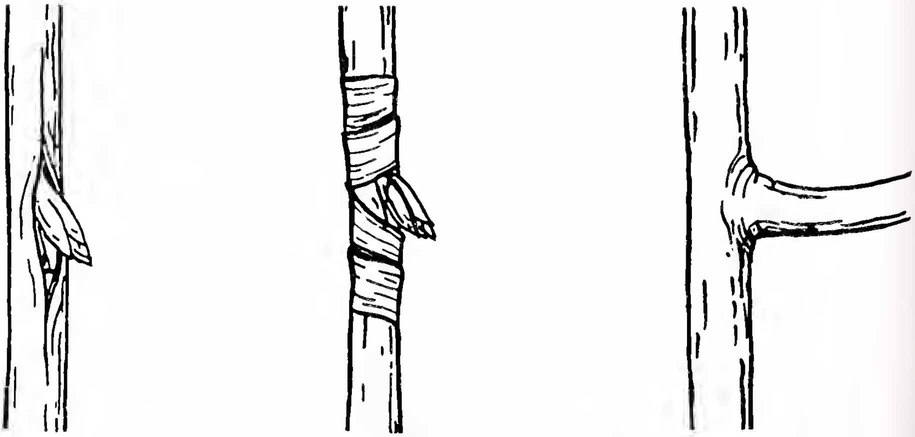
Knotted young apple tree, one year after budding.

Strengthening Crotches by Inversion of Buds

Dwarf fruit trees bear very heavily in proportion to their size and so need particularly strong branches to carry their heavy loads of fruit. When a bud is inserted in its normal upright position, a narrow weak crotch often results, as indicated by the first three drawings. Dr. Sax has found that inserting the bud upside down produces a wider, stronger crotch and gives the branches greater spread (second three drawings below). It has also been found that trees with spreading branches, such as these, bear earlier (photograph opposite).



Normal method of budding. Bud inserted in slit in bark of root stock, in usual upright position, and wrapped with rubber budding band. Narrow crotch often results.



Bud inserted upside down produces a wide strong crotch.

Stayman Winesap apple, with spreading, early-fruiting branches, the result of upside-down budding.

An Explanation?

After seeing the pygmy-edition fruit trees produced by Dr. Sax and his students, one immediately asks, "What is the cause behind the dwarfing effect?" The answers are still somewhat nebulous, but Dr. Sax says this: "For hundreds of years horticulturists have used various methods for producing dwarf fruit trees but so far little is known about the whys of the dwarfing effect. Preliminary experiments seem to indicate that the dwarfing effect of inverted bark, knotted stems, and some interstocks may be caused by the checking of hormone flow from the scions to the root stocks upon which they are grafted."

KRILIUM AND ITS RIVALS

What is it? What does it do? How was it developed?
"The most important agricultural discovery of the decade"

Harland Manchester

Condensed from *Harper's Magazine*, September, 1952

THE original Krilium, as well as most of the soil conditioners which have appeared since under other trade names, has been derived from *acrylonitrile*, a chemical obtained from natural gas which is used in plastics, synthetic rubber, insecticides, and other products, and is the basic raw material for Orlon, Dynel, and the other new acrylic fibers.

This chemical soil conditioner is not a fertilizer, and it contains no food for plants. It gets results solely by its physical action on the soil. It converts fine, hard, packed-down clayey soils that are lacking in organic materials into crumbly, easily workable dirt which quickly absorbs water and because of its porous nature makes it easy for air to get to the roots and for the roots to search for food. It also prevents surface crust formation, thus removing a barrier which often smothers seedlings in their struggle for emergence.

There is nothing new about soil conditioning. No matter how much plant food is added in the form of commercial fertilizer, plants won't thrive if the soil is too dense. Among the traditional methods of loosening up tight soils and improving friability, or tilth, is the addition of organic materials like manure, compost, and peat moss and the plowing in of green crops. But it may take several years to improve soil structure by these methods, and the task is endless because the natural chemicals produced are vulnerable to bacteria. The new synthetic conditioners resist bacteria. The first soil

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treated with Krilium three years ago still retains its crumbly, growth-promoting form, and chemists see no reason why the effect should not last several years more.

Research

The path which led to Krilium began thirteen years ago in a corn field, when scientist-farmer Charles A. Thomas, now president of Monsanto Chemical Company, looked over his crop and wondered why large patches were yellow and stunted. He talked to his neighbor Carroll Hochwalt, Monsanto vice-president, and found that he was having the same trouble. Fields that looked the same and received the same fertilizer didn't give the same yield. When they analyzed samples in the research laboratory, they found that they contained the same proportions of plant foods as the high-yielding areas. Both soils had the necessary trace elements, and a comparison of a dozen other factors failed to reveal the answer. They found that this puzzling condition was widespread. Monsanto, a big producer of agricultural chemicals, set a few men to work on a research project.

The villain, they found, was soil structure. You could use the best seed, add plenty of fertilizer, and have adequate rainfall, but unless the soil particles were clumped together in favorable sizes—ranging preferably from the size of a pinhead to that of a pea—you couldn't get a really good yield.

For thirty years soil scientists had been working on the same problem. They had found that decaying vegetable matter produced natural soil-binding "glues" called *polyuronides* which gave soil the desirable loose, porous structure. These account, in part, for the huge yields obtained for many years from virgin crop land reclaimed from forest. The land is eventually played out unless more organic matter is constantly added, and it takes from fifty to a hundred tons of such matter to produce a single ton of the rapidly decomposing natural glues which keep the soil in shape.

Seeking a more efficient way of doing Nature's work, Monsanto's men began testing the effect of various chemicals on soil. They knew that a long-chain molecule, similar to that of a plastic, was needed to hook up the tiny soil particles. They built hundreds of these molecules in test tubes. And thousands of compounds and concentrations were tested. They emerged with a number of chemicals that would do the job, and from these they selected the compound called Krilium, which has a long molecule similar to that of nylon.

"You can get an idea of what this compound does to soil," Dr. Thomas explains, "if you think of the molecule as a long stick, bearing several hundred little magnets, which is thrown into a heap of iron filings. In similar fashion, the negative charges on Krilium hook onto the positive charge on particles of clay, forming small lumps. The 'sticks' not only hook the tiny particles together, they brace them apart, leaving little interstices. Soil composed of these particles has a spongelike structure through which air, water, and germinating plants can easily pass. At least that's how we think it works."

Experiments

Pilot-plant quantities of Krilium were produced for distribution to dozens of greenhouses and experiment stations. Enthusiastic reports rolled in. At Ohio State University, scientists tried it on plots of tough, gummy soil which breaks up into large clods when plowed and sticks to harrows and planting implements when damp. Rain does not easily penetrate such soils; water forms in puddles and runs off. They sprinkled the powder on the surface and harrowed it in. In twenty-four hours anyone could pick up a handful of dirt and tell the difference, and for two years the results have been dramatic. The treated soil grew 40 per cent more oats than adjoining plots, the yield of marketable carrots rose 21 per cent, and there was an increase of 15 bushels an acre in field corn. Beets matured faster and came out of the ground cleaner.

They regard chemical soil-conditioning as easily the most important agricultural discovery of the decade, with an important future in increasing crop yields and the workability of soils otherwise structurally unsuitable. They point out that it would be of no value in well cared-for fields already packed with organic materials, for it does nothing but improve soil structure. Nor would it help very sandy soil; for chemical reasons it won't hook grains of sand together. There remain great areas of rain-slaked clayey soils which produce poorly—some experts say as much as half our arable land—and in these soils the powerful new "cement" may work miraculous changes.

Surface crust which keeps seedlings from emerging is a problem on big New Jersey market farms, especially with carrots, lettuce, and spinach, and experiments at Rutgers showed that a very small amount of Krilium prevented crust formation and hastened growth.

Other users add to the story. Last year horticulturists at Purdue University, with no idea of the merits of the unknown powder, obtained a sample and worked it into a patch of soil which had the poorest possible physical condition. Chinese-cabbage headed up a week earlier, and beets, carrots, and turnips grew to sizes 20 per cent (and more) larger than in the control plots. The loose, treated soil absorbed water so quickly that it could be cultivated soon after a heavy rain, while untreated plots could not be worked for several days.

Soil conditioners can do a completely different reclamation job in the irrigated ranches of the southwest, where salts leached from the mountains eventually season the soil so heavily that it is difficult to flush them out and good crops will no longer grow. At the United States Department of Agriculture's Salinity Laboratory at Riverside, California, tests have shown that the loose soil structure created by Krilium aids in washing out the deposits and putting the soil back in production.

One must bear in mind that all these experiment-station tests have been made on small plots, and that the Krilium used was supplied free of charge by the manufacturer. After watching it work, soil experts believe that it is technically possible for chemical conditioners to upgrade many millions of acres of farm land throughout the world; but their enthusiasm is tempered by their belief that use on large acreages would probably be economically impossible at present prices. Monsanto chemists estimate that it will take anywhere from 200 to 1,000 pounds per acre to do a satisfactory job on soils lacking in organic matter, and the present price, as sold in 5-pound packages, is $1.39 a pound.

Rivals

When Monsanto first announced Krilium [December, 1951] no competitor was in sight. The company had applied for patents; they stated that it would not be offered to the general public until early 1953. But by late June, 1952, some twenty firms had disregarded Monsanto's patent claims and entered the field. Krilium-type soil conditioners were being sold under such trade names as Aerotil, Agrigair, Agrilon, Aerisoil, Fluffium, Loamium, Orthotil, Poly-Ack, Soilife, Soiloam, and Terra Kem. Many of these acrylonitrile-based preparations were said to be identical with the original Krilium or just as good. Their appearance forced Monsanto's hand, and a few weeks after the first one appeared the company set up its own distribution system and put its own soil conditioner on the market.

The soil conditioners are now being sold in three forms:

(1) As a powder to be worked thoroughly into the soil when the seed bed is prepared.

(2) As easily soluble flakes to be mixed with water and sprayed upon prepared soil with an ordinary garden sprinkler.

(3) As a premixed liquid which according to some advertisers will cause soil particles to aggregate, assisting the penetration of air, water, and plant roots when sprayed upon unworked ground or existing lawns.

If we take the attitude that there is no substitute for a couple of growing seasons in testing any new soil preparation, we will grade the proved effectiveness of these preparations in the order listed. Many tests have shown if the powder is harrowed into clay soil when it is dry to a depth of about 3 inches in a quantity of at least 200 pounds per acre, and is later sprinkled, an aggregation of particles takes place which appears to last for a long time. Soil thus treated absorbs rain water at once, while on control plots of untreated soil, water gathers in puddles and runs off.

No deep penetration is achieved by the second method; so far as is known, the effect is limited to preventing the formation of surface crust. This probably assists plants to emerge and helps the soil to absorb more water. But it cannot lighten the soil at the root level and therefore does not aid the process of plant nutrition.

As for the third method, advertised as a labor saver, there is no evidence that it is of value. The chemical will not break up hard soil. The soil must be well worked before it is applied.

Assorted hucksters are bringing discredit to a major agricultural discovery. Leading experts disagree with claims made by certain firms that the preparations will improve sandy soil. Sand particles cannot take part in the electrolytic action of agglomeration. To use conditioners on muck or other soil heavily loaded with organic materials is a waste of money, like taking medicine when you are not sick. Gardeners can also get into trouble by misusing the products. Too much of them on the hands may be irritating. Tests have shown that a heavy application on plants that have emerged may blight them. A heavy surface application which is not worked in may form a thick crust, preventing anything from growing.

Other Uses

Meanwhile, valuable nonagricultural uses have been found for the compounds. A tennis court that had been experimentally treated with Krilium was dry enough for play fifteen minutes after a heavy downpour which normally would have put a clay court out of commission fo hours.

Another use is the stabilization of raw shoulders of new highways and other exposed slopes against gullying and erosion by rainfall. When sprinkled on the surface the chemical forms a film which doe not prevent the absorption of water but ties soil particles together so that rain will not carry them off. Krilium has been added to water containing grass seed and fertilizer and sprayed from a tank truck on fresh highway cuts, thus stabilizing, seeding, and fertilizing the soil in the same operation.

A bulldozer scraped off the top soil in a housing project, exposing the hard clay subsoil, the worst growing medium imaginable. Monsanto's scientists harrowed in some Krilium and commercial fertilizer and grew a good crop on it which was remarkably free of weeds, since weed seeds had been scraped off with the topsoil. This may lead to a simpler and cheaper method of landscaping the raw grounds of newly built houses.

Future

The greatest promise of the conditioners is in increasing the yield of field crops on land which now produces poorly because of its unfavorable structure. The pace of their adoption on large acreages will be set by the angle of the downward price curve which is expected to result from huge demand. Three big chemical companies are building acrylonitrile plants which will enter production next year. Although much of the product will be used to make fabrics and plastics, the size of the industry's investment definitely indicates solid faith in the future of soil conditioners.

Not merely a new product, but a new principle, has been discovered. Thousands of long-chain polymers await testing, some of which may do the job better and cheaper than those now in use.

This new field of research should attract able recruits; for soil scientists are confident that eventually the discovery will play an important rôle in boosting world food production.

STOP, THIEF!

A protest against appropriation of topsoil by contractors

R. Milton Carleton

Condensed from *Popular Gardening*, March, 1952

IF a family fortune that took generations to accumulate were filched from anyone, there'd be a cry for legal action. Yet each year hundreds of thousands of American families are cheated out of a small fortune that takes eight to ten centuries to make, and not a voice is heard in protest.

What is Stolen

Every time a home site from which black dirt* has been removed is sold, the owner is robbed as surely as if the seller had hit him over the head and stolen the cash out of his pocket. Although the owner of new property may not know it, he has had taken from him soil that (by natural process) only centuries can build back, or that may be replaced by other means only at a stiff price. The offense against him is particularly cruel because it is committed at a time when he has probably spent his last cent in building a house and has nothing left with which to buy nourishment for his beggared land.

Who Steals It

There are no laws, to speak of, that prevent builders, contractors, or so-called

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*Topsoil.—Ed.

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developers from appropriating black soil of property on which they construct houses. Plundering land not theirs and so robbing purchasers of their right to lawns and gardens is not considered immoral. On the contrary, topsoil belonging to someone else is thought, by nine out of ten builders, to be a source of legitimate profit.

So a most subtle, heartless fraud goes on unchecked. The homeowner is uninformed and defenseless. He, more often than not, is unaware of the betrayal and theft. He is not warned, when he gets a new house, that his topsoil has been lifted and that the thin layer sprinkled over his property is but a screen to hide his loss; that the green fuzz of grass he watches hopefully will dry up and disappear as soon as its roots penetrate to the clay or sand beneath.

If he were to prod under the veneer of black topping he'd be shocked at his discovery. Instead of the 6 to 12 inches of rich, black earth he has a right to expect, he'd find boulders, brick-hard clay, or arid sand. Here and there, he'd see patches of broken plaster, waste concrete, and—yes, scraps of sheet iron—packed down hard by heavy bulldozers.

Remedies

It is high time that a halt were called to this mass betrayal. An ideal way to handle the situation would be to enact and enforce laws. But there are other ways to end the deception and stop the thieves, too.

First. Forewarned is forearmed. Buy your new home with a spade in hand. Do not accept that neat-looking lawn area around a newly built house at face value. If your contractor is honest he will not mind your lifting some of the black top-dressing to see what's underneath. Don't dig where he suggests. Try spots near the foundation (a favorite dumping ground for trash from construction). If the builder has skinned off the topsoil you will know it and you can bet your bottom dollar he also has not hesitated to skimp on the carpentry, heating, lighting, plumbing. If the grounds are not as they should be, don't buy. You'll save yourself headaches all around in the end.

Second. If you are building your own home, consult your architect about grading. Have him estimate the volume of topsoil and supervise its removal to a spot where it may be piled up in safety.

Third. Gardening agencies should come forward to do something about the fraud perpetrated on the men and women who usually become their associates and customers as soon as they acquire property. Garden clubs and horticultural societies should work with landscapemen, nurserymen, and seedsmen to make local builders realize what evil they do in taking other people's topsoil.

Fourth. Home communities, loan companies, and other interested persons or organizations should also take steps to stop the thieves. Legislation alone, as we all know, is not the answer.

One town passed an ordinance but specifically exempted building sites from its provisions. Logically such a law should be a part of the building code and should be administered by the building inspection department.

If laws specified that not less than 6 to 8 inches of topsoil must be used over rough grading, the community would benefit with the homeowner. Obviously, beautiful lawns, trees, and gardens are an asset to any town.

Finally. Building and loan associations, which now finance most of the country's housing, are in a position to crack the whip. To my knowledge no such association has as yet set up and enforced a provision calling for a minimum covering of black soil as a prerequisite to a loan.

Nothing in the world would be so great a deterrent to the theft of topsoil as a provision that would back up the homeowner and allow him to withhold final payment on construction until his grounds were properly covered with a specified minimum of topsoil—which was his in the first place!

KNOW THE ODDS WHEN YOU GAMBLE ON HARDINESS

What determines winter survival and what can be done to extend the northward limits of plants

Freeman A. Weiss

Condensed from *The Home Garden*, November, 1952

SOMEONE has said that farming is the greatest gamble on earth and farmers the most persistent gamblers. Gardeners, too, share this propensity to gamble—and not alone on the weather; it is equally manifest in the perennial urge to attempt the cultivation of new and different plants.

In its most used sense, hardiness means the ability of a plant to survive the winter in any given region. Actually, factors other than low temperature (whether it be the absolute minimum reached or the duration of freezing) greatly influence hardiness; but temperature is usually the most important, and regardless of other factors, the one which finally determines where a plant can survive.

Maps

Since the minimum temperatures of winter drop, and their duration increases, approximately with the latitude, it is relatively easy to draw maps of hardiness based on latitude, and correspondingly easy to understand them. This has been done, for instance, by Rehder and Wyman of the Arnold Arboretum, who have designated ten hardiness zones into which North America can be divided, and have classified the woody plants cultivated in this region on the basis of the northernmost zone in which they ordinarily will survive.

More complex maps of plant distribution as influenced by climate have been developed by plant geographers of the United States Department of Agriculture —Mulford, Thoruthwaite, Marbut, and Van Dersal — who have superimposed maps of rainfall, evaporation rate, length of growing season, and soil type upon the zones that are approximately isothermal, in an attempt to integrate the principal factors which determine where plants will grow. They call the areas thus delimited "plant growth regions" and have presented extensive classifications of woody plants in relation to these.

Temperature

Low temperature is the first test a plant must pass to qualify as hardy, and we have distinguished two aspects of low temperature that determine the outcome. The first of these is the **minimum temperature** to which the plant is exposed. Some plants will succumb to short exposures to 0°F., while others readily survive this but pass out at temperature 20° to 30° below 0° F., however gradually they are chilled to this level. (Of course we exclude tropical species that will not stand freezing at all.)

Second, there is the effect of **prolonged exposure**: a plant may survive after only a few hours or a day or two of subzero temperature but will succumb after a week or two. When, as periodically occurs, there is a month or two of continuous subzero weather, we have a real test winter which gives us more basic information on the absolute hardiness of plants than a decade of average winters.

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Everyone knows that an **abrupt drop of temperature** (especially if it occurs early in the winter before the plants have sunk deeply into dormancy) is more injurious than a gradual decline. Some species of plants, or even different horticultural varieties, are light sleepers and are prone to renew vital activity in response to only a few days of warm weather, and then are injured nearly as much by a sudden chill as if they had never become dormant at all. Thus a conservative reaction to temperature changes is an important factor in plant hardiness.

Moisture

Although one form of low-temperature injury is literally **freezing to death**, another is really **slow desiccation.** Cold air is usually dry air because much of its moisture has been frozen out. If it is not only dry but moving rapidly, as in a high wind, it deprives plants of vital moisture even more. When the ground is frozen so that the roots cannot absorb water and restore that lost from the plant by evaporation, death from drought may occur in winter even though the plant is dormant. Damage from this source is frequent in evergreens because water loss is greater through needle leaves or scale leaves (admirably adapted as they are to conserve water) than through no leaves at all, as in deciduous plants. Sometimes this form of lack of hardiness is only the consequence of a dry fall, which leaves the soil too depleted of moisture to provide the plants' minimum requirement.

Soil

The type of soil, and its condition, which in turn determine its properties of supplying or holding water, are important hardiness factors. A thin, sandy soil that will not retain moisture, a clay soil that will not give it up, a bare soil that freezes deeply and dries quickly on the surface, are inimical to hardiness even though the climatic factors are not particularly adverse.

Heredity

Finally, the inherent characteristics of the plant, and its ancestry, may profoundly affect its ability to survive.

Counter Measures

The counter measures which can be taken to offset the adverse factors will in some cases be self-evident.

Material. For our experiments in extending the approved range, we shall choose plants that are not more than two zones removed from their normal hardiness zone—and one is safer. The hardiness maps and tables in horticultural manuals such as Wyman's *Shrubs and Vines for American Gardens* will guide us in this choice.

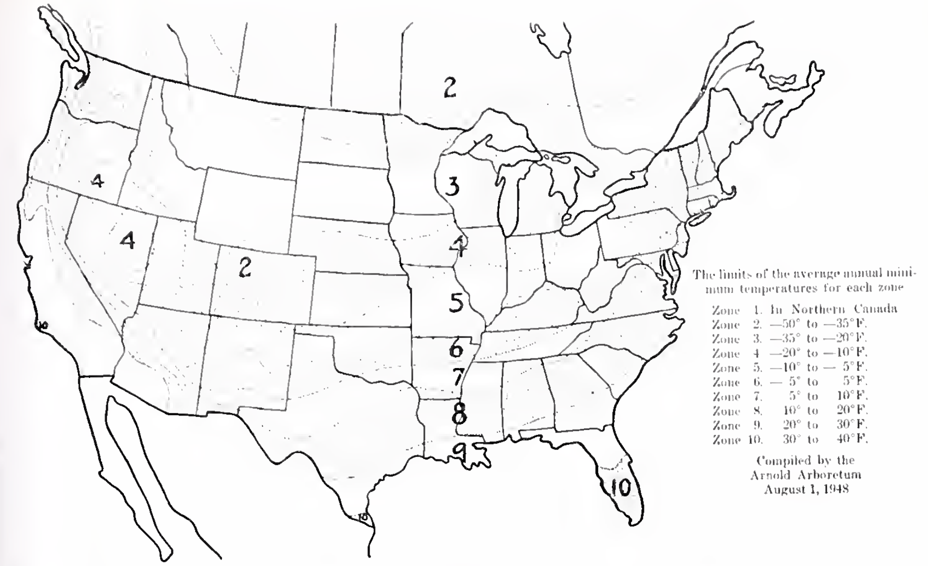
We shall give preference to nursery or native plants that have grown near the northern limit of their range, and as a rule avoid very young plants.

Site. We shall select naturally sheltered planting sites, or create them, taking into account protection from cold drying winds and also from the sun that shines too hot when the calendar says it is winter.

Soil. Among the important requirements of the soil are texture and drainage such as will encourage deep root penetration, and composition that will insure a lasting and equable moisture supply; also balance as to soil nutrients.

There must also be, during the growing season, sufficient available nitrogen to permit a normal amount of shoot growth but not excessive vegetative vigor. A semistarved plant is almost as poor a hardiness risk as an overfed one, though of course the prime easy mark for a hard winter is a plant that is overwatered and overfertilized late in the growing season. The general object in fertilizing is to concentrate vegetative growth into the first half of summer, withholding all fertilizer and gradually cutting down on water after midsummer so that there is ample time for the new growth to harden off.

In the event that Nature provides such continuously favorable growing conditions throughout the season that maturity



The limits of the average annual minimum temperatures for each zone

Zone 1. In Northern Canada
Zone 2. —50° to —35°F.
Zone 3. —35° to —20°F.
Zone 4 —20° to —10°F.
Zone 5. —10° to — 5°F.
Zone 6. — 5° to 5°F.
Zone 7. 5° to 10°F.
Zone 8. 10° to 20°F.
Zone 9. 20° to 30°F.
Zone 10. 30° to 40°F.

Compiled by the
Arnold Arboretum
August 1, 1948

Map reprinted with permission of the Macmillan Company, from Shrubs and Vines for American Gardens, *by Donald Wyman. Copyright 1949*

Hardiness zones.

seems likely to be delayed, it may be possible to induce artificial hardening off with a potassium fertilizer in late summer, a pound or two per 100 square feet.

Mulch. Naturally we shall make sure that, once growth is stopped and freezing weather is approaching, there is an ample supply of soil moisture; after this we can apply a liberal mulch (in case we have not used one in summer), giving preference to materials that are loose, bulky, and not inclined to remain water-soaked and packed. Ground corncobs, buckwheat hulls, pine straw, tan bark, sawdust, or shredded leaves will do. A mulch preserves soil moisture, tempers changes of temperature, and helps to prevent deep freezing of the ground.

Protection. The use of artificial screens and covers for winter protection is a subject by itself. It should be emphasized, however, that tight covers may impede air circulation and cause heating in the sun to the extent that the plant suffocates. Wrapping materials such as straw, marsh hay, and pine or other evergreen branches, may be very useful in exposed locations and for especially cold-sensitive plants but should be loose and bulky, never dense or tight.

Results

What will measures such as these really accomplish in extending the northward limits within which we can grow plants of our choice with a fair prospect of success? Speaking from local experience in Washington, D. C. (about the northern boundary of Hardiness Zone 7), it appears that the outdoor cultivation of camellias, long considered the special prerogative of the Far South, is an accomplished fact here. Large-flowered evergreen azaleas of the so-called Indian group are no longer a novelty, and some plants are beginning to approach in size those of southern gardens. There are choice specimens of English holly, and a few of dahoon (*Ilex cassine*) not far from Washington.

From almost every other locality similar records of extracurricular horticultural accomplishments can be gleaned—English ivy in northern Illinois, torch azaleas in Duluth, *Daphne odora* in New Jersey, Korean boxwood in Ontario, sequoias in Rhode Island and central New York. There is always room for horticultural pioneering, and almost any of us can play this game of beating the hardiness limits right at home. Of course, we don't always win!

AIR LAYERING WITH PLASTICS

An improved technique for an old method of increasing woody plants rapidly

John L. Creech

Condensed from *Popular Gardening*, June, 1952

EACH year the enterprising amateur gardener seeks some new experience. Air layering with plastics will be an interesting new propagation technique to try.

The art of air layering is an ancient one, known in one form or another for centuries. The method was devised as a substitute for mound layering when a branch or plant could not be bent to the ground and mounded with earth.

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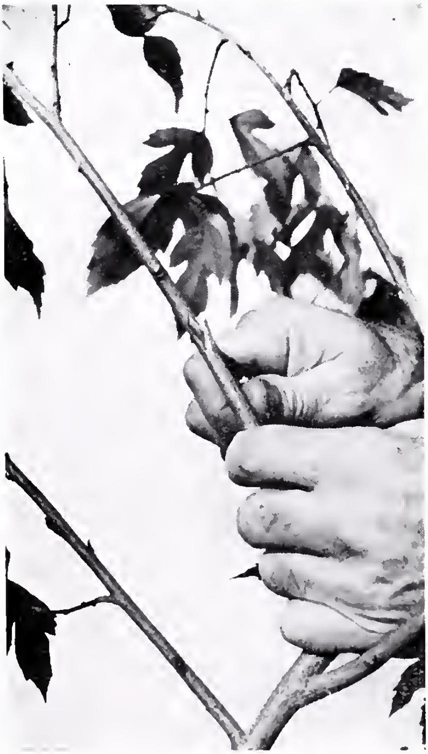
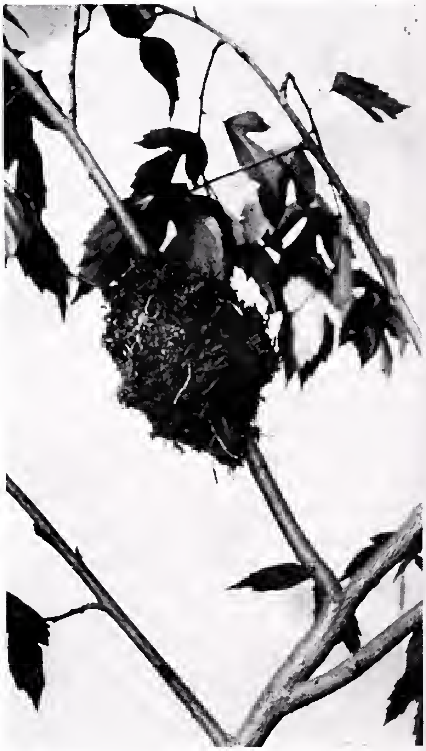


The stem is notched or girdled and a small amount of root-inducing powder is immediately inserted into the cut.



Photos courtesy H. Gleason Mattoon

Moist sphagnum moss is pressed around wounded stem. If compressed it will stay in place until wrapped.

Explanation

In air layering, a branch is wounded and bound with moist sphagnum moss held in place with string or raffia. Sometimes a container is fashioned by splitting a pot in halves lengthwise and placing it around the moss. Or a wire cage, lined with oiled paper, is used to protect the moss and keep it from drying.

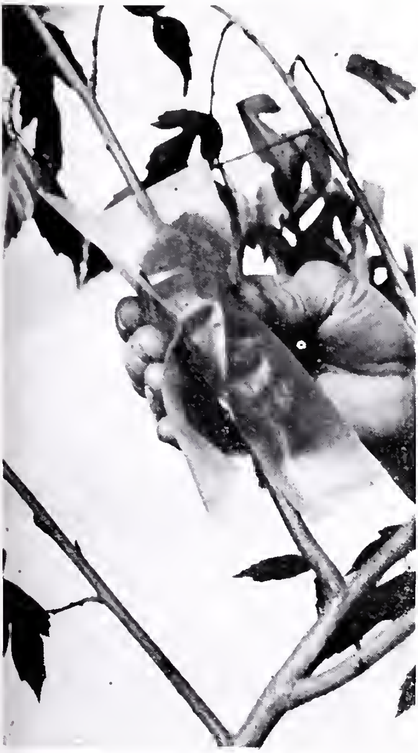
When the sphagnum is encased in a plastic wrapping that prevents the moss from drying, the method can be used on woody plants growing in the garden. With this method, a miniature propagation chamber is created. For the plastic retains moisture, and during the summer, the heat of the sun as well.

Under such conditions, plants that do initiate roots along the stem will infiltrate the moss with roots by the end of the summer. As with any other method, not all plants can be expected to root in the same manner or degree.

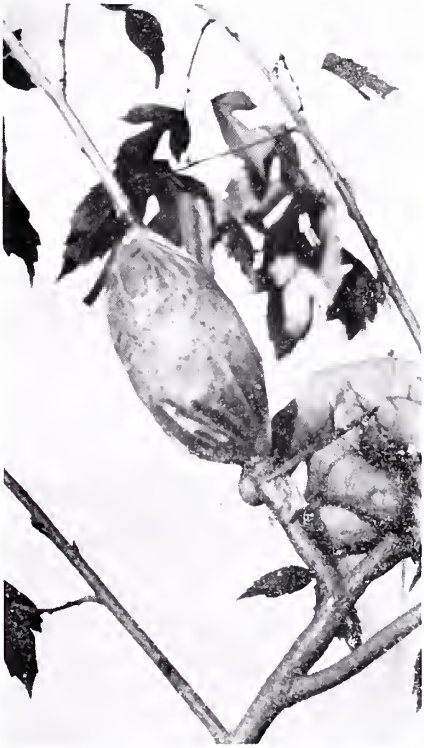
For example, rhododendrons display a wide variation in the ease with which they air layer. The variety Mrs. C. S. SARGENT is easily propagated, as is AMERICA. *Rhododendron discolor*, however, layers only with difficulty and then very slowly. *Enkianthus* and *Aucuba* layer without difficulty. Some of the dogwoods are most responsive. Many other common garden shrubs also undoubtedly air layer without difficulty. Air layering with plastics is now used by commercial growers in Florida to propagate tropical fruits and ornamentals.

Method

To air layer with plastics, select (in the spring) branches that will make a shapely plant, preferably those that are vertical



A sheet of moisture-proof plastic is then wrapped around the moss so that it overlaps one third of the distance around.



Plastic is twisted spirally at the top and bottom and secured with rubber bands, to make moisture-proof bag.

or nearly so. To allow for several inches of working space, remove a sufficient number of side shoots or twigs on last year's wood and even remove older branches. With a sharp knife, either "tongue" the stem by cutting into and downward parallel to the sides of the stem, or girdle the branch gently. Dust the wound with one of the standard root-inducing agents.

Sphagnum moss is the most satisfactory medium to use as a wrap for the stem. It has high moisture-retaining capacity and is light in weight, clean, and relatively sterile. To prepare sphagnum properly, moisten it by slowly syringing it with a watering can, mixing the moss by hand until it is damp and adherent. Plunging the moss into a tub of water and then attempting to wring it dry will invite failure. When the moss has been moistened, ball it in the hands and then press it around the stem.

Take a 6- by 9-inch sheet of moisture-proof plastic and wrap it around the moss so that it overlaps sufficiently to prevent any gaps. To finish, twist the plastic around the stem and tie it first at the top and then at the bottom. This produces a moisture-proof bag around the sphagnum. As with any other technique, there may be a few failures before an efficient wrapping is made.

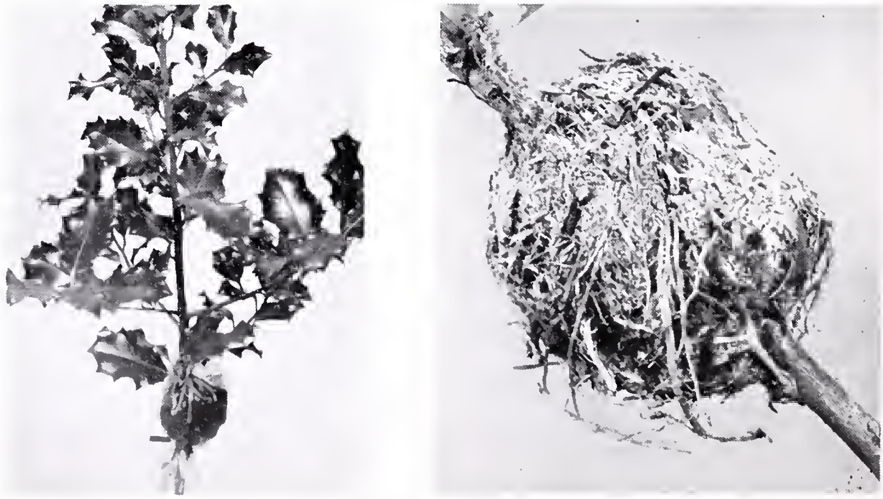
Once the wrap is tied securely, it should be left on the plant until sometime in late August when it may be opened to permit examination of the layer for roots. With some plants, such as dogwoods, the heavy roots show through the plastic. Finely rooted plants, however, do not push roots to the outside of the moss as rapidly.

Care

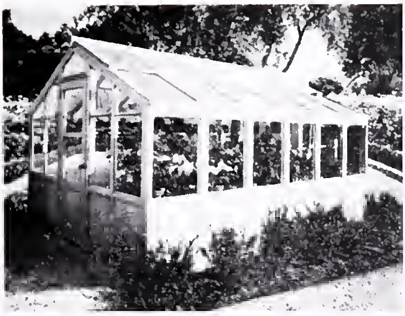
When rooted, the layer is cut off the parent plant just below the lower binding, and potted without disturbing the moss, with enough soil to fill the pot. The plastic will still be in good condition and may be saved for use the following year.

Until it is established, the potted layer should be placed in a shaded location where the humidity is high. Since the ball of moss holds moisture, water must be applied carefully so that the layer does not get more than it needs.

With a knowledge of the mechanics of wrapping layers in plastics, one may produce plants much larger than with any other method of propagation.

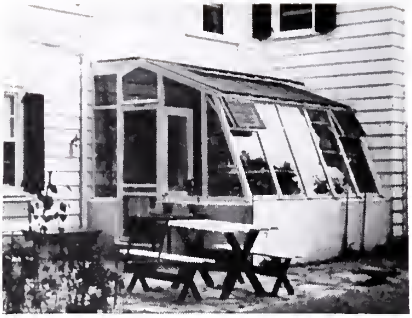


This 22-inch air layer of English holly is ready to be severed from the parent branch. When the plastic is removed from the layer, the heavy roots filling the sphagnum moss are easily seen. Some of the roots have pulled away from the moss.



Metropolitan

A standard type detached greenhouse.



Lord and Burnham

A snugly fitted-in lean-to, with slat shading.

WHICH GREENHOUSE FOR YOU?

What size? For what purpose? How heated? Attached to dwelling or separate?

F. F. Rockwell

Condensed from *The Home Garden*, August, 1952

ASK any greenhouse owner what garden investment he considers the most rewarding he ever made, and the chances are a hundred to one he will reply, "The money I spent for a greenhouse!" Follow this question up with a second one, "How much did you spend?"—and no two answers will be the same.

Many factors affect the cost of a greenhouse. Chief among these are the type of construction, the amount of work the owner himself can do in building it, and the facilities available for heating it. Cost isn't the only matter to be given consideration. If you really want to have one, you'll get it.

Purpose

The use to which it is to be put will depend on your personal tastes and interests. Most gardeners want a general-purpose house—one suited to the growing of many different flowers and operated throughout the winter months. Such a house is usually equipped with raised benches and is sufficiently wide to accommodate at least a center walk and two side benches.

If the greenhouse is to be used primarily for starting seedlings, it may be unnecessary to operate it throughout the winter. This of course eliminates one of the greatest items of operating expense.

Temperature and Light

The prospective greenhouse builder should realize in advance that not all kinds of plants can be grown in the same **temperature.** Greenhouse plants are usually referred to as belonging to one of three groups: coolhouse (40° to 50° F.); temperate (50° to 60° F.); and hothouse (60° to 70° F.). These figures are average night temperatures; day temperatures run 5 to 10 degrees higher.

To have plants do their best, they should be at the required temperature. Many subjects in the cool and the temperate groups, or in the temperate and the hothouse groups, will get along fairly well in the same temperature; but the two extremes cannot be grown together.

In a fairly large greenhouse different temperatures can be maintained by putting in glass partitions, but in a small one this is not practical. It is practical,

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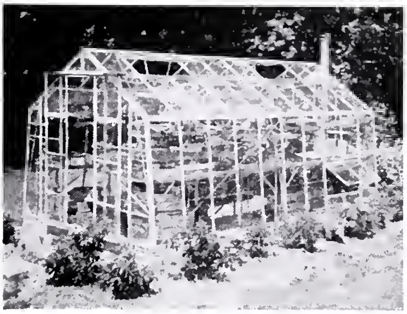
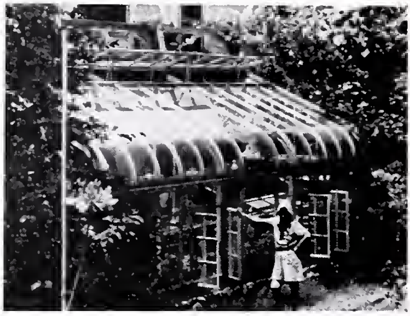


Waldor

Detached greenhouse with glass to ground, permitting use of space under benches.



Author Courtesy

The author's greenhouse, a curved-eave lean-to; windows in sides permit wide open ventilation.

even in a small house, to build a special propagating frame for starting seeds, making cuttings, and other purposes requiring a high temperature.

Light limitations must also be considered. Some plants require all the direct sunlight they can get, especially during the winter months; others, varying degrees of shade. As shaded areas can be provided fairly readily, it is usually best to plan for all the sunshine possible, unless the house is to be used for some special purpose such as growing camellias, African-violets, tuberous begonias, or other plants that do not need full light.

Location

In general it is desirable to give it the sunniest spot possible, facing south or east. If along with this can go a maximum degree of protection from winter winds, you have the ideal location.

Make sure that your greenhouse will get full *winter* sun. Summer shade, on the other hand—as from deciduous trees—may be a positive advantage for a general-purpose house.

Care

A greenhouse, even a small one, will not take care of itself. The amount of time required to attend to it will depend largely upon what is grown. A miscellaneous collection of many plants will need much more attention than a specialized group of but a few kinds.

Regularity in attention is quite as important as the total time given. Half an hour a day, every day, will be sufficient to care for a goodly number of plants.

More space is available when shelves are built above the benches.

Roche

If some assistance in caring for the routine chores of watering and ventilating is available, that will help immeasurably.

Ventilation, especially, should be attended to when it is needed—and this, in hot weather, may be several times a day. However, there are now on the market automatic ventilating devices which are sufficiently reliable to solve this problem for greenhouses of almost any size.

Heating

Hot air, hot water, and steam are all used successfully in small houses, but hot water is preferable since it is more even and does not lower the humidity as rapidly as the others. Thermostatic control of the temperature within the greenhouse is desirable but by no means essential. A number of very small greenhouses are successfully heated by arranging a method of bringing in warm air from a house cellar where there is a heater.

Attached or Detached

The advantages of an attached greenhouse are: somewhat lower cost of construction; usually more protection from winds; greater accessibility, making for both a great saving in time and the possibility of enjoying the greenhouse in everyday living. It also lessens the problem of temperature control, as the heating system can be attached directly to that of the residence. This usually does not put an overload on the heating system, as the greenhouse requires most heat during the night when the demand for heat in the house is low. Furthermore, if there is a door or a window connecting house and greenhouse, on bright sunny days between September and May the greenhouse can actually help heat the house.

The disadvantages are a shorter period of full direct sunlight during the day (in most instances) and the possibility of an undesirable degree of heat—even with the ventilators wide open—during sunny summer days.

The advantages of a detached greenhouse are: greater light; keeping the messiness of greenhouse operations away from the residence; easier handling of soils, compost, flats, and the like, and of transferring plants from outside to inside and *vice versa.* Also it is much easier to extend a detached house, if that ever is desirable.

A greenhouse offers a way of stepping up the production of plants, and extends the joys of gardening around the year.

Roche

WHAT MY GARDEN MEANS TO ME

While close to the sod, there can be seen
A thought of God, in white and green

Geraldine Farrar

Reprinted from *Horticulture,* October, 1952

ONCE upon a time, it was my happy fortune to be active in the world of song. This usually conjures up a ravishing picture of glamour, exciting travel, and general adulation. But the hours of relaxation are few and far between; and despite the plaudits and the fervor of public acclaim, a career, by reason of its many responsibilities, is very much of a hot-house affair.

The singer and the hot-house plant share a superheated, carefully tended shelter, designed for unusual and exotic results. Hence, one is necessarily weaned away from more simple environments. The orchid (far from its native tropics) and the singer are both restricted to artificial stimulation in the setting of designed elegance that attests their particular virtues. For it is not in the normal scheme of things to tax a human throat in competition with a thunderous orchestra. Nor can a scientist coax to his proud will the latest hybrid in laboratory excitement for superfloral achievement. Such efforts can constitute genius, and the resultant spectacular effects cannot be denied.

My own garden efforts are far removed from stellar ambitions. They are intended to bring solace to a troubled spirit, as they deal with a memory that will forever remain bright and lasting through the years.

Some time ago, on a spring morning, I left the grime of train travel to return to my green hills and village tranquillity. Daffodils rippled in an exquisite golden carpet at my feet. It was a feast for eyes that had only seen, in landscapes, through the blurred windows of the train, skies stifled under smoke, fog, and rain, as a relentless machine bore me to various singing duties.

Here at home were clean clear air, blue sky, and nature enchanting! I breathed deeply, happily conscious of the bubbling brook garlanded with anemones. There were shady woods where the generous earth shielded frail blossoms and invited the climbing embrace of trailing vines. I thrilled to these early vernal delights.

Then came June. Irises, like knights

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of legend, breasted the gentle breezes in serried ranks. Roses and lilies nodded in their sparkling collars of dew; larkspur and Canterbury bells swayed to their own fairy chimes. All these lovely, unhurried arrivals came according to their seasonal cue.

A garden is like a church; it carries a benediction, as summer blooms give way to the glorious banners of autumn. Then the earth rests to renew her fecund magic slowly from under snowy covers. Again it's spring!

Perhaps it is because I have known so many exotic blossoms as tributes that I have a fellow feeling and a nostalgia for the more simple expressions of Queen Flora. I like my violets clustered in riotous welcome along green borders; I prefer my pansies under an open sky, where apple blossoms float in rosy clouds overhead. I have a stab in my heart to see that shy woodland beauty, the trailing arbutus, trussed in a hempen noose and hawked about city streets till the delicate bloom succumbs. I like my laundry yard wreathed in pungent honeysuckle: a harbor at all times for the birds and furry mites, mindful of the scattered tidbits accorded their needs in season.

How good and sane is country living! It gives time to think, to enjoy, to observe. It awakens one to patient lessons from patient plants and burgeoning trees that swell and bud, with a daily reminder of our glorious birthright. A basic need of all human creatures is to be soothed and healed in the everyday confusion and to be set aright on fundamental paths that lead to one's best endeavors.

If a stray seed falls from some feathered voyager above my roof tops, it will not become an intruder in any carefully designed garden scheme. I let my acres run according to their understanding with Nature.

If you have ever read that delightful "Mr. Twigg's Mistake" (all about a fascinating mole, who went by the name, euphoniously enough, of De Gaulle!), mole runs will never again cause you any agonizing concern on your front lawn.

Do you quiver at field mice? If so, you should make the acquaintance of "Amos," who nestled in Ben Franklin's fur cap (the diplomatic pouch of that era) and who was, so he relates, the real ambassador to cement the *entente cordiale* between the sister republics. So engaging a little liar will predispose you to all small animal life.

What are half-nibbled bulbs when you can see bright eyes peering from a rocky wall pocket, with just the whisk of a tiny body making for the fern thatch? If my dachshunds give chase and tread upon growing things in pursuit, I am not suddenly thrown into a tizzy.

As I have little appreciation or enthusiasm for stylized flower arrangements, I expect the horticultural expert will frown at my inefficiency. Maybe so. Nor do I shudder if a brazen zinnia crowds a delicate petunia or if the phlox "reverts" to a shrieking magenta, for Nature has been at work. Not I! I am pleased and have no qualms about color schemes, form combinations, or seasonal specimens. For me, a flower is always a miracle, whether in the garden or in the field, and very frankly, my feeling goes beyond any stated pattern.

With the years, as in all things, affectation reveals itself, and no less than in the snobbish garden attitudes. My shrubs and flowers are not the choicest, the largest, or the rarest. They are in no way unusual, but depend on Nature for kindly ministrations in this day of manpower shortage. She rewards me richly, as my heart sings in contemplation.

Roche

''The memory of stillness and the smell of fallen leaves.''

BRING THE WOODS INDOORS IN WINTER

And make your own terrarium, large or small, from collected or bought material

Olga Bockes

Condensed from *Flower Grower*, October, 1952

WHY not re-create a particular bit of your woodland in a glass container? A cordial glass, an antique goblet, a glass milk pitcher will do as well as a fish bowl or one of those tremendous demijohns.

In the miniature world of a terrarium the elements of the larger terrain are present. What is needed is patience in bringing these elements together in such a way that they will survive, choosing plants that will live with one another in harmony. Once the terrarium is made, maintenance is negligible, for moisture condensing on the sides and top of the bowl waters the soil whence it came.

What to Gather

Gathering the material is naturally the first, as well as the most important step. There are commercial growers who raise evergreen woodland plants, and for those who do not have access to their own woods or who want to purchase plants protected by conservation lists in their particular state, these growers are recommended.

Pipsissewa (*Chimaphila*) is most likely to be flung along a well drained hillside in flickering sunlight, whereas hepaticas prefer the cool rich soil and dense shade near a stream. Ground-pine (*Lycopo-*

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A bit of rugged woodland re-created in an aquarium.

dium) is fairly common and useful in terrariums, as are the true woods violets and bright red partridge-berries (*Mitchella repens*).

You may find one or several of the wintergreens (*Gaultheria*) or the pyrolas, or on dry sunny banks the delicate fern ebony spleenwort (*Asplenium platyneuron*). But if you come across one of the true rarities, like walking fern (*Camptosorus rhizophyllus*), found among limestone rock clefts in shade, you will never forget it.

Consider the size and shape of the glass in which you intend to build your garden. Consistency is the prime factor. The plants chosen must be in accord with the size of the bowl, with one another, and with the season.

Pyrola, for example, which has a large elliptical leaf, could not be used in a 3-inch bowl. It would be wiser to use the moss *Catharinea angustata* to give the effect of a forest in such a bowl, with only the tiniest wood violets and partridge-berries to augment it. Whereas in a 12-inch bowl, clumps of lycopodium, chains of shining club-moss, masses of pipsissewa are not out of place.

Fall is the best time to establish a woodland terrarium. Choose, therefore, only the evergreens or such perennials as hepatica which rest during the summer and may well bloom in the false April of your terrarium.

It is imperative to know something about the mosses you gather. The bog mosses will not be lush when used side by side with thin, dry tree mosses. Too much moisture induces mold in some mosses; yet some of the loveliest of these small plants produce new growth on the brown desiccated stems of the season past.

How to Gather

The tools you will need to gather this plant material are simple: any sharp implement can be used to cut deeply around the plants, and a trowel will lift them. For most mosses, a pancake turner does the neatest job.

Carry a light cardboard box or wooden flat over the rough terrain and return with it occasionally to a larger flat receptacle which is half-filled with humus. A layer of newspaper between layers of mosses will enable you to stack them and yet keep them clean.

Roche

Wilderness in miniature.

Before entering the forest it is well to review a sort of litany of conservation. Never take more plants than you need to fill your bowl. Where there is a single specimen, pass it by; and do not take a plant with an unopened seed pod—it is likely to resent transplanting and it is also ready to replenish the forest.

How to Put It Together

When you are ready to make your terrarium, gather around you the materials you will need: glass containers and their tops, small pebbles for the bottom layer, sand to cover them, a few pieces of charcoal, humus which has been sifted, rocks to make the contours if you choose, slate to make steps and whatever embellishments you have chosen, tweezers to remove debris, and scissors to trim your plants and fashion your moss.

The first step in assembling plants in the bowl is to cut the thinnest piece of moss to the contour of the scene you have in mind; pick it clean with tweezers and use it, green side out, to line the bottom and sides of the bowl.

A flat planting is never as interesting as one with hills and cliffs. Contriving these in a small bowl requires ingenuity but it can be done. Place whatever large rocks you need to form your contour, allowing the top third or so to show above your planting.

Then add a layer of sharp sand mixed with powdered charcoal and cover that with twice as much pure humus, to the level desired. Moisten this slightly and begin planting.

Clean your plants with tweezers, cut off any dead leaves, dip the plant tops in a cup of water to wash off any dirt that may have adhered, and with your green thumb or a pencil make holes big enough to take the plant roots. Put the plants in their holes and cover them with humus, pressing down gently.

When your terrarium is complete, wipe the glass inside and out with a clean towel. Then spray the plants with a fine mist until the earth has absorbed just enough moisture to exude a bit when pressed.

Care—and Enjoyment

Whenever the top and sides of the container become cloudy, raise the cover for a short time. Keep your terrarium cool, never in direct sunlight.

The best thing about a terrarium is the element of surprise. That is what makes it such an ideal gift for children and invalids. Some morning you may peer into your small glass world and find a seedling pine has poked through, or the cotyledon of a moccasin-flower. A hepatica or a violet may bloom. There may appear flocks of tiny moths, or the ubiquitous earthworm, none of which will injure your plants but which will provide diversion. You may even find yourself boarding a slim red salamander or a cricket to sing all winter.

There is a bit of verse that suits the uses of terrarium makers: ". . . Anything can happen, anything at all . . ." with greens and humus and a big glass ball.

MAKING A BOG GARDEN WITH SPHAGNUM

To provide special conditions for growing native orchids and certain other plants that will not thrive in an ordinary garden bed

G. G. Nearing

Condensed from *Bulletin of the American Rock Garden Society*, September-October, 1951

Courtesy A. T. Beals

Rein orchis (*Habenaria ciliaris*).

THE bog, with no drainage at all, caters to those plants which must have their roots always sopping wet. In nature we find many sorts of bogs.

In each sort of bog, every few steps lead to a different condition, with a vegetation of its own. To be told that a plant comes from the bog is not enough to enable us to care for it properly. We must also learn what kind of bog.

The sphagnum bog, alike the world over, has a special flora strange and delightful. Here grow the orchids *Arethusa,* grass-pink (*Calopogon*), *Calypso,* rein orchis (*Habenaria*), and lady-slipper (*Cypripedium*); also wild calla (*Calla palustris*), bog-asphodel (*Narthecium*), *Andromeda,* the insect-eating plants, and countless other treasures.

Natural Sphagnum Bogs

Sphagnum moss covers perhaps a twentieth of the land area of the earth. Yet it has no roots, nor any firm hold on what it blankets. Under it is dead sphagnum, its own decayed stems, which in a thousand years form peat, in a million, coal. As fast as it grows upward it dies below. It stands upright because countless crowding stems of sphagnum around it keep if from falling over. When you step on it, your foot sinks deep.

Wherever sphagnum grows it creates acidity, and the common characteristic of the plants which thrive in it is that they require this acidity to maintain health. Therefore the moisture around it should be essentially stagnant. There should be no drainage or flowing floods to wash this acidity away, for even though without it the moss might remain alive, the plants for which it is to furnish a rooting medium might not.

In seasons of drought, when water is comparatively low in the bog, the tops of the sphagnum often turn brown or

Published by the American Rock Garden Society, Bound Brook, New Jersey.

A man-made bog at the Brooklyn Botanic Garden, with wild calla (*Calla palustris*) and pitcher-plant (*Sarracenia purpurea*).

whitish, and appear to be dying, especially in summer and under conditions of full sunlight. Unless it dries out completely, however, rains and dull autumn weather will soon turn it green again, with bright red tips for some species.

Site and Construction

With all these facts in mind, choose the site of your bog. Individual ingenuity has hit upon a number of devices for retaining the water: an old bathtub, stoppered and sunk in the ground, a steel tank, a concrete reservoir, a hole dug to below water level near the bank of a pond, a low spot enclosed by dikes. In any case it must hold water, and the water must be maintained at a fairly constant level with no very perceptible flow. It must be first a stagnant pool.

This pool you fill with peat moss, which is merely the commercial name for ground-up peat, derived from sphagnum moss.

As soon as the peat is thoroughly wet (and the wetting may take a long time, even weeks or months), bring growing sphagnum from a wild bog which has approximately the same exposure to the sun. Do not try to stand it up as you found it growing, because to do so would require an enormous amount, and because in that position it will die. Pull the strands apart, scattering them thickly over the wet peat surface. If this is done in late winter or early spring, each strand will turn up its tip, grow rapidly, and soon begin to branch. By the end of the season you will have a well developed sphagnum cushion.

Planting

Once the cushion has formed, you may plant in it any species which comes out of sphagnum, with an excellent prospect that it will grow. Transplanting, in fact, is no trouble at all. But weeding will be necessary, for grasses, sedges, and weeds rush in to establish themselves on the same tufts where you plant the orchids.

Courtesy American Nurseryman

Part of the crab apple collection at Swarthmore College, Swarthmore, Pennsylvania.

EVALUATING THE FLOWERING CRABS

Highly desirable ornamental trees that should be in more home gardens

John C. Wister

Condensed from *American Nurseryman*, April 15, 1952

THE Japanese cherries at Washington, D. C., have had such great publicity that the general public will think of them whenever flowering trees are mentioned. No one disputes their beauty, but it is my purpose to call attention to the fact that the flowering crab apples are quite as beautiful, are much more varied, have beauty of autumn fruit in addition to their flowers, and are much hardier. They can be grown in practically all parts of the United States except perhaps the extreme South, and many of them are hardy in Canada.

Botanists usually list about twenty-five species in five groups and then subsections, and there is much confusion regarding many of these. There is, unfortunately, no commonly accepted dividing point between crab apples grown for ornament and those grown for fruit in commercial orchards, nor is there even an accepted dividing line between a crab apple and an apple.

Wyman, in *Crab Apples for America*, makes a dividing line on the size of the fruit being under 2 inches and lists some ninety-seven kinds that were available in American nurseries in 1943.

The most complete collection in this country is that of Arie F. den Boer, at Waterworks Park, Des Moines, Iowa. Mr. den Boer is working on the manuscript of a book, and many nurserymen will not like his conclusion that in his own experience at least 75 per cent of all the crab apples sold are not true to name. Unfortunately, many nurseries have been careless in their labeling, but this great mix-up is only partially due to this. It is partially due to the confusion in arboretums, but its main cause is the fact that in the past many plants have been grown from seeds and sent out under the name of the seed parent. As far as known, only two important species, *Malus hupehensis* and *M. toringoides*, come true to type from seeds. Seeds taken from any other species have probably been hybridized by bees, and the resulting plants vary greatly from the true type.

Horticultural classification is simple. Crab apples can be divided into Asiatic and American types. Nearly all the Asiatic ones bloom before the American ones.

Asiatic Types

Smaller groups can, of course, be made in each of these two main groups. It is convenient to subdivide the Asiatic species by type of growth. *Malus baccata*, the Siberian species, and its hybrid, *M. robusta*, form very large trees unsuited to the average suburban garden. The

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Courtesy American Nurseryman

Crab apples lend beauty to Swarthmore Campus.

Japanese flowering crab (*M. floribunda*) and its hybrids, and the Arnold crab (*M. arnoldiana*), the tea crab (*M. hupehensis*), the Toringo crab (*M. sieboldi*), and the Hall crab (*M. halliana*), are all of medium size, with white flowers tinged with pink.

Deeper in color but of the same general type are the Parkman crab (*M. halliana parkmani*) and the carmine crab (*M. atrosanguinea*). *M. sieboldi* and *M. zumi* Calocarpa and *zumi* Bobwhite are particularly important for holding their fine fruit exceedingly late.

To these white and pink medium-size trees should be added the group of early-blooming purplish hybrids of *Malus pumila niedzwetskyana*. This apple, not worthy of garden position itself, transmits deep color of flower, wood, and fruit to its seedlings. The first of these hybrids to become well known is the purple crab (*M. purpurea*). The Eley crab is slightly smaller. Both bloom very early. A good number of new varieties of this general coloring are coming into commerce, among them Kingsmere, Makamik and Wabiskaw. It is my opinion that a few of them go a long way, as the colors are dingy. One of them surrounded by five or six of the species mentioned earlier is a good ratio for planting.

The variety Aldenham is the latest of this group, and the variety Lemoine, the reddest in general commerce. Mr. den Boer's patented variety, Crimson King, gives promise of being a most important addition to the group.

Of the Asiatic types, the Sargent crab (*M. sargenti*) is the smallest, and this is suited for the city garden. It is a true tree, not a shrub, and will grow into a single trunk 6 or 8 inches in diameter and still not be over 6 or 8 feet tall by perhaps 10 feet across. Its flowers are white, fruit red.

American Types

The commonest American species are the wild sweet crab (*M. coronaria*) and the prairie crab (*M. ioensis*). They are wild over large sections of this country, the former through our southeastern states and the latter through the Middle West. The best known variety of *M. ioensis* is the double-flowered Bechtel

Prairie crab apple (*Malus ioensis*) at the Brooklyn Botanic Garden.

crab (*M. ioensis plena*). It is possible that the new varieties, Nieuwland, Boone Park, and Nova, will replace it in the future. The best known variety of *M. coronaria* is Charlotte.

Malus platycarpa hoopesi, of our southern states, is a much larger shrub or tree than either of these, equally beautiful with large pale pink fragrant flowers, but it is not suited for the small place. All these, as before mentioned, are late-blooming, coming at Swarthmore, Pennsylvania, in late May, while the Asiatic crabs bloom during the first and second weeks of that month, and some kinds, such as the purple crab (*M. purpurea*), often open in April. *M. purpurea* is so early that its purple-pinkish flowers often make a bad contrast with forsythia, and it should not be planted near it.

The latest of all the crab apples is the southern crab (*M. angustifolia*)—of our southern states—and the variety Prince Georges is a double form, a hybrid of this.

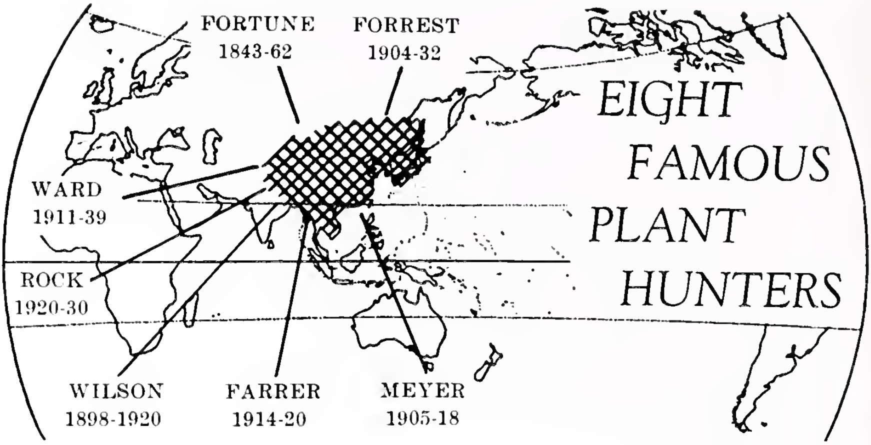
All crab apples are commonly grafted or budded on commercial apple stocks, but some of the American kinds are not congenial on this root stock. By deep planting, most apples can be induced to send out their roots above the graft. Plants can be easily grown from layers in the home garden, but this is hardly practical for nurserymen. Young grafts should make 18 inches to 3 feet the first growing season and are large enough for permanent location after the second or third year.

Care

The crab apples are tolerant concerning soil conditions and planting situations. They need little pruning and are more attractive when pruning is avoided.

Scale insects are the only important pests and can easily be controlled by dormant miscible oil or lime-sulfur spray. One species, *M. toringoides*, is notoriously subject to fire blight in some sections, and the Bechtel crab seems particularly susceptible to cedar rust and should not be planted where this is prevalent.

City gardens can, of course, use only the smallest-growing species, but in many suburban gardens there is ample space for enough medium-size growers to give a good succession of bloom following magnolias and the cherries.



Dates indicate periods of activity in exploring for plants. Cross-hatching shows the area from which the plants mentioned were obtained.

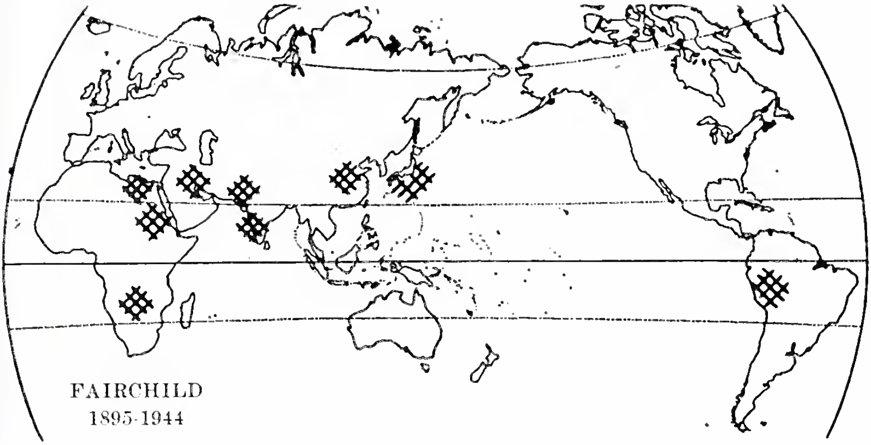
As gardeners we are indebted to the Plant Hunters whose brief biographies appear here

Donald G. Huttleston

DID it ever occur to you that each of the plants in your garden grows wild in some part of the world? If you ever really thought about it, you probably realized that this is true; but many persons have never stopped to think of it. Strictly, that question should have a qualification, because many garden plants, such as roses, irises, and chrysanthemums, have been considerably changed by hybridization and selective breeding. It is a fact, however, that man has never originated anything drastically new in plants: he has only succeeded in modifying what already exists.

A logical question now to be asked is "Who first brought these plants into cultivation?" Knowledge of the actual introduction of most cultivated plants has become lost in antiquity. At first, man simply began taking some care of the useful plants around him. Later, people passed on to others some of the plants which they grew. With the advent of ornamental gardening the same sequence of events took place. Then, when extensive travel and exploration began, persons who were visiting countries other than their own took home seeds of plants new to them. In Japan and China, where ornamental gardening probably originated, such plants as chrysanthemums, rhododendrons, and flowering cherries have been in cultivation for centuries; and no one has any idea who first grew or developed them.

In the nineteenth century the actual profession of plant exploration began. Governments, nurseries, and interested persons sent men to distant parts of the world with the express purpose of searching out plants that would be valuable or ornamental. Since 1800 many men have pursued this career; but certain names, such as Fortune, Meyer, Farrer, and Wilson, are most familiar. These men have been directly responsible for the introduction into cultivation of many plants now well known, as well as for the spread of plants already in cultivation to other parts of the world. Following is a brief account of a few of these explorers and some of the plants they introduced.



ERNEST H. WILSON was responsible for the introduction into cultivation of more than 1500 species of plants.

He was born in Gloucestershire, England, February 15, 1876. After his early schooling he was employed in nurseries until 1892, when he began work at the Birmingham Botanical Gardens and study of botany in the Birmingham Technical School. In 1897 he went to the Royal Botanic Gardens at Kew.

In 1898 he was hired by James Veitch and Sons, a famous English nursery, to go to China with the sole purpose of obtaining seeds of the dove-tree (*Davidia involucrata*), which was known only from descriptions and pressed specimens. In 1903 he made a second trip to China for Veitch Nurseries. Shortly after his return, he was asked by Professor Sargent to make a third expedition to China in behalf of the Arnold Arboretum of Harvard University. This he did in 1907. He subsequently made four additional trips for the Arnold Arboretum: China in 1910; Japan in 1914; Japan, Korea, and Formosa in 1917; and South Africa, Australia, India, New Zealand, and Tasmania in 1920.

In October, 1930, Mr. Wilson and his wife were killed in an automobile accident near Worcester, Massachusetts. His only daughter, Muriel, married George L. Slate, who is Professor of Pomology at the New York State Agricultural Experiment Station at Geneva, New York.

Some of the best-known plants that Wilson introduced are:

The **dove-tree** (*Davidia involucrata*), which is very striking when in flower, because of the large white flower bracts that resemble handkerchiefs hanging on the tree. Seeds from western China were first planted in England in 1901.

The **regal lily** (*Lilium regale*) requires no description. Introduced from western China in 1910.

Beauty-bush (*Kolkwitzia amabilis*), a large shrub with a profusion of pink flowers similar to those of weigela. Introduced from China in 1901.

The **tea crab apple** (*Malus hupehensis*), a small tree with an abundance of white or pinkish flowers and magnificent small red fruits. Introduced from China in 1900.

Chinese dogwood (*Cornus kousa chinensis*), which is similar to our flowering dogwood (*Cornus florida*), except that it blooms a month later. Sent from China in 1907.

Chinese neillia (*Neillia sinensis*), an attractive shrub with tubular pink flowers in nodding clusters. Introduced from central China in 1901.

Tree false-spirea (*Sorbaria arborea*), a tall shrub which grows to a height of 20

Flowering branch of Chinese neillia (*Neillia sinensis*), introduced by Ernest H. Wilson.

feet, with great clusters of small white flowers. Introduced from central and western China in 1908.

Wilson barberry (*Berberis wilsonae*), an excellent low rockery or border shrub with narrow leaves, yellow flowers, and red berries. Sent from western China in 1903.

Summer-lilac (*Buddleia davidi magnifica*), a handsome shrub with long clusters of bright violet flowers with orange centers. NOT a true lilac (*Syringa*). From central China in 1900.

Korean box (*Buxus microphylla koreana*), a low hardy box for northern gardens. Introduced from Korea in 1919.

Leather-leaf viburnum (*Viburnum rhytidophyllum*), a handsome shrub with dark green, partially evergreen, wrinkled leaves; white flowers; and red fruits. Introduced from central and western China in 1900.

ROBERT FORTUNE was the first of the great professional collectors. The Royal Horticultural Society sent him to China soon after that country was opened to western exploration. Because of the difficulties of travel and the animosity that persisted toward westerners, his collecting was restricted mostly to the coastal strip and the gardens there. Most of his collections, therefore, were already in cultivation in Chinese gardens. It was he who first brought the many varieties of chrysanthemums and peonies out of China.

Fortune was born in Kellow, Berwickshire, Scotland, September 16, 1812, and it was there that he served his garden apprenticeship. In 1839 he entered the Edinburgh Botanic Garden. Two and one-half years later he went to the Horticultural Society Gardens at Cheswick.

During his first visit to China for the Royal Horticultural Society (1843 to 1846) he visited the treaty ports along the China coast. He made two trips to China and Formosa (1848 and 1853) for the East India Company, during which he was primarily collecting tea. His final expedition, from 1858 or 1860 to 1862, took him to China and Japan for the United States Government.

In 1862 he retired and took up farming in Scotland, where he died April 13, 1880.

Some of the most important of the ornamentals he introduced are the following:

Pink-bell abelia (*Abelia uniflora*), an attractive evergreen shrub with lustrous, dark green leaves and tubular whitish pink blossoms which are orange in the throat. Collected in the Bohea Mountains of China in 1845.

Fuzzy deutzia (*Deutzia scabra*), one of the most popular of the deutzias, with a profusion of clustered whitish bell-shaped flowers in June. Introduced from China in 1822.

Golden-bells (*Forsythia viridissima*), one of the best-liked of the forsythias. Sent from China in 1844.

Chinese holly (*Ilex cornuta*), popular, lustrous-leaved. From eastern China in 1846.

Winter jasmine (*Jasminum nudiflorum*), a hardy species with yellow fragrant flowers borne late in winter. Introduced from eastern China in 1844.

Winter honeysuckle (*Lonicera fragrantissima*), the earliest and one of the most fragrant of the honeysuckles, with pale yellow flowers opening before the leaves. Sent from eastern China in 1845.

Amoena azalea (*Rhododendron obtusum amoenum*), low hardy evergreen, with rich magenta flowers; a great favorite. Introduced from eastern China in 1850.

Linden viburnum (*Viburnum dilatatum*), with white flowers and brilliant scarlet fruits; much planted in gardens. Sent from China in 1845.

Bleeding-heart (*Dicentra spectabilis*). Brought from China in 1860.

REGINALD FARRER was probably the most versatile of the plant explorers. Not only did he travel widely, collect plants, and write about gardening, but he also wrote fiction, historical novels, and plays and even dabbled in politics.

He was born in Ingleborough in Yorkshire, England, in 1880. Physical disability prevented him from going to school and so he was tutored at home. This allowed him freedom to wander his neighborhood hills and develop an acute interest in plants. At 14 he started a rock garden, and for the remainder of his life he possessed a growing interest in rock garden and alpine plants. At 33 he wrote "The English Rock Garden."

Flowering branch of winter jasmine (*Jasminum nudiflorum*), introduced by Robert Fortune.

The fact that we are not indebted to him for a great many garden plants is due to circumstances beyond his control. On his first expedition he visited western China with William Purdon and spent 1914 and 1915 there. Though he collected extensively, most of the plants were unfortunately lost to cultivation because of the sharp decline in the popularity of gardening during the first world war.

In 1919 he went to upper Burma on his second expedition, this time with E. H. M. Cox. Mr. Cox returned to England late in 1919, leaving Farrer in Burma. This time all the Fates were against him, and he died there October 17, 1920. Few of the many new plants found on his last expedition ever reached England.

Despite all this, it was Reginald Ferrer who introduced the following plants to our gardens:

Farrer aster (*Aster farreri*), a striking plant with large single flowers (3 inches

George Forrest brought the fairy primrose (*Primula malacoides*) to the western world.

wide) having slender lavender-blue rays and orange centers. Collected in extreme western China in 1915.

Tangut barberry (*Berberis dasystachya*), a tall species with broad, bright green leaves and coral-red fruits. Sent from western China in 1915.

The **fountain butterfly-bush** (*Buddleia alternifolia*), the hardiest and earliest-flowering of the buddleias, with long arching branches covered with bunches of lilac-purple flowers. Introduced from western China in 1914.

The **fragrant viburnum** (*Viburnum fragrans*), an attractive shrub with sweet white flowers appearing before the leaves. Collected in western China in 1915.

Farrer rose (*Rosa farreri*), an attractive species with an abundance of small, single, pale pink or white flowers. Introduced from western China in 1915.

Cox juniper (*Juniperus coxi*), a large tree with greenish white needles and black berries. Sent from upper Burma in 1920.

Farrer gentian (*Gentiana farreri*), a small plant having large blue flowers with white throats and with yellow markings on the petals. Introduced from western China in 1915.

Purple-elf rhododendron (*Rhododendron calostrotum*), a very small shrublet with 1¾-inch flowers which are bright red-purple. Introduced from northeastern Burma in 1920.

GEORGE FORREST was one of the largest operators among plant collectors; he had a number of trained natives in his employ. Between 1904 and 1932 he made seven expeditions to Yunnan and southeastern Tibet. He and his men collected such a wealth of material that, even after twenty years, it has not all been studied.

He was born in Falkirk near Edinburgh, Scotland, March 13, 1873.

His first expedition was financed by A. K. Bulley of Nester, England; and subsequent trips were supported by a group of prominent British horticulturists. The part of China he covered lies almost entirely between 20° and 24° North Latitude and 98° and 101° East Longitude. Even during the short periods between his expeditions, his trained native collectors were amassing material. His collections number some 30,000, though this includes pressed plants as well as seeds and living plants.

He died in the field in Tengyueh, Yunnan, January 5, 1932.

Following are some of the better-known of his introductions:

Fairy primrose (*Primula malacoides*), a popular greenhouse plant with white to bright pink flowers. Introduced from western China in 1908.

Forrest fir (*Abies forresti*), an attractive tree with red-brown branches, and needles that are whitish beneath. Introduced from western China in 1910.

Yunnan crab apple (*Malus yunnanensis*), a tree with white flowers, red fruits, and leaves which turn orange and scarlet in the fall. Introduced from western China in 1908.

Bees jasmine (*Jasminum beesianum*), a slender climbing shrub with fragrant pink or carmine flowers and black fruit. Introduced from western China in 1906.

Sea-buckthorn rhododendron (*Rhododendron hippophaeoides*), a dwarf evergreen species with pink or lavender-blue flowers. It is hardy as far north as southern New Jersey. Introduced from western China in 1908.

Yunnan globe-flower (*Trollius yunnanensis*), with rich, golden yellow flowers sometimes double. Introduced from western China in 1906.

Chinese gentian (*Gentiana sino-ornata*), a small plant with large, deep blue flowers blooming over a long period. Introduced from northwestern Yunnan in 1904.

F. KINGDON WARD has doubtless spent more time in the field than any other plant explorer. That the number of his introductions is not greater can be explained by the fact that he, like Farrer, worked chiefly alone. He did all his own collecting; and every plant that he introduced, he saw in the growing condition.

Ward was born in England, November 6, 1885, son of the late Harry Marshall Ward, who was Professor of Botany at the Royal Indian Engineering College, then at Cooper Hill, and later at the University of Cambridge, England. It is little wonder that the son became interested in botany. Kingdon entered Christ's College, Cambridge, in 1904. Early in 1907 he became a schoolmaster in Shanghai.

His real introduction to exploration came in 1909, when he joined the late Malcolm P. Anderson on a journey across China.

In 1911, Bees Ltd. of Liverpool (a nursery owned by A. K. Bulley) hired Ward to explore northwestern Yunnan for new kinds of plants. (It was Bulley who started George Forrest on his career.) From 1911 until 1939, Ward traveled almost continuously in China and Tibet.

Mr. Ward is at present living in London.

Following are some of the better-known of F. Kingdon Ward's introductions:

Violet-bead barberry (*Berberis hypokeriana*), a low species with spiny leaves that are whitish beneath, and blue-violet fruits. Introduced from Burma in 1930.

Berberis calliantha, an attractive **barberry** with rough leaves and large flowers. Introduced from southeastern Tibet in 1931.

Frank Nickolas Meyer brought Chinese hawthorn (*Crataegus pinnatifida*) from China in 1913.

Campanula calcicola, a tiny **bellflower** having kidney-shaped olive-green leaves with pale jade-colored veins, and large, deep violet flowers. Collected in western China in 1922.

Wintergreen cotoneaster (*Cotoneaster conspicua*), a showy evergreen with small leaves and a profusion of scarlet fruits. Sent from western China in 1925.

Ward cotoneaster (*Cotoneaster wardi*), an attractive species with branches and undersurfaces of leaves whitish. Introduced from southeastern Tibet in 1931.

Ward wintergreen (*Gaultheria wardi*), an attractive evergreen shrub with clusters of small jug-shaped pinkish flowers. Introduced from southeastern Tibet in 1933.

Meconopsis betonicifolia baileyi, the blue "**poppy**" for which Ward is famous. Introduced from Tibet in 1924.

The **ledge primrose** (*Primula rupicola*), with clusters of mauve, yellow-eyed flowers. The plant has a white mealy covering, which gives it an attractive grayish appearance. Introduced from western China in 1922.

Ward rhododendron (*Rhododendron wardi*), an attractive evergreen with large yellow flowers. Introduced from western China in 1913.

FRANK NICKOLAS MEYER was the first plant explorer that the United States Department of Agriculture sent to eastern Asia with a major assignment. He was born in Holland and spent his childhood in Amsterdam; but the exact time and place of his birth seem to be unknown. Before coming to America in 1900, he was for eight years an assistant to the famous plant breeder Hugo de Vries. In 1905 he was employed by the United States Department of Agriculture as a plant explorer; between that time and 1918 he made four expeditions to Asia. The expeditions were:

- 1905-08, northern China, Manchuria, and northern Korea.
- 1909-11, The Caucasus, Russian Turkestan, Chinese Turkestan, and Siberia.
- 1912-15, northwestern China from Kansu Province to the border of Tibet.
- 1916-18, China: Jehol, north of Peking, and around Ichang.

The details of his death will never be known; he disappeared from the deck of a steamer on the Yangtze River during the night of June 1, 1918. His body was recovered from the river the following day.

Though he sent back more than 2500 introductions from his expeditions, the great majority of them were improved varieties of plants that were already well known. For this reason it is difficult to select well-known introductions. A few of his plants are as follows:

The **lace-bark pine** (*Pinus bungeana*), a stately tree with striking white bark. Brought from Shansi, China, in 1908.

Dwarf, or **Siberian,** or **"Chinese" elm** (*Ulmus pumila*), a very hardy shade tree. From near Peking in 1908.

Weeping Siberian elm (*Ulmus pumila pendula*), a beautiful variety with pendent branches. Also from near Peking in 1908.

Manchu rose (*Rosa xanthina*), which is much used as hardy grafting stock for other roses. Brought from Shansi, China, in 1908.

Actinidia (*Actinidia kolomikta*), a vine with fruit very similar to gooseberries. Sent from Chihli, China, in 1907.

Evergreen chinquapin (*Castanopsis tibetana*), a large-leaved evergreen with edible nuts resembling chestnuts. It does well in warm-temperate regions. From Shanghai in 1908.

Laurel cherry or **cherry-laurel** (*Prunus laurocerasus*), a form of evergreen cherry that is much more cold resistant than those previously known. From Russian Caucasus in 1910.

Chinese hawthorn (*Crataegus pinnatifida*), an edible haw used for preserves. Sent from Shantung, China, in 1913.

JOSEPH F. ROCK was another explorer who was employed by the United States Department of Agriculture.

He was born in Vienna, Austria, January 13, 1884. From 1907 to 1920 he was in the peculiar position of being joint professor of botany and Chinese in the College of Hawaii. During this time, in 1913, he became a United States citizen.

The United States Departmet of Agriculture sent him to Burma, Assam, and Siam as a plant collector in 1920. Since then he has spent almost the entire time in China. His first project for the Department of Agriculture was to search for the chaulmoogra-tree.

Rock was appointed director of the National Geographic Society's Yunnan-Tibet Expedition in 1923. The following year he became director of the Arnold Arboretum-Harvard University Botanical and Zoological Expedition to western China and Tibet. He held this position until 1927, when he joined the National Geographic Society's Southwest China-Tibet Expedition. He was active on this expedition until 1930. Since 1945 he has been a research fellow connected with the Harvard-Yenching Institute. This is a joint research institute of Harvard University and Yenching University in Peiping.

As was the case with Meyer and Fairchild, the great majority of Rock's introductions were better varieties of already well-known plants. A few of his introductions are as follows:

Chaulmoogra-tree (*Taraktogenos kurzi*), the seeds of which contain an oil used to treat leprosy. Sent from Burma in 1921.

Chaulmoogra-tree (*Hydnocarpus anthelminthicus*), which is valuable for the same reason as the former. Collected in Siam in 1920.

Prunus majestica, which may prove a source of **cherries** for the South or of more resistant stock for northern cherries. Collected in Yunnan, China, in 1922.

David lily (*Lilium davidi*), a 3- to 4-foot lily with flowers ranging from orange-yellow to red and red-brown. Sent from Yunnan in 1922.

Himalayan prinsepia (*Prinsepia utilis*), a very early-flowering shrub bearing a profusion of white flowers. From Yunnan in 1922.

Side-flower primrose (*Primula secundiflora*), a species with clusters of drooping, deep purple flowers. Sent from Yunnan in 1923.

Drooping anemone (*Anemone demissa*), a lovely alpine with leaves in a basal rosette and clusters of large white flowers. Collected in Yunnan in 1923.

Incarvillea (*Incarvillea compacta grandiflora*), a very early spring-flowering plant with glossy, dark green leaves and 2- to 3-inch, magenta-purple flowers with yellow throats. From Yunnan in 1923.

Rock-jasmine (*Androsace spinulifera*), a rock plant with basal leaves and clusters of rich pink, very attractive flowers. Sent from Yunnan in 1923.

DAVID FAIRCHILD has done more for American agriculture and gardening than any other one person. Few will contest this statement. Although he has brought in a great many plants, his contributions have by no means been limited to his own introductions. He has been indirectly responsible for the introduction of a tremendous number of plants. He organized the Office of Plant Introduction of the United States Department of Agriculture and was in charge of it from 1906 to 1928. It was he who was responsible for the hiring of Frank Meyer, Joseph Rock, and other explorers; and his contacts with numerous botanists, horticulturists, and others throughout the world have resulted in the importation of countless plants. It would be impossible to evaluate the contributions that Fairchild has made to gardens. He is still at work at his home in Florida.

Fairchild was born April 7, 1869, in Lansing, Michigan, where his father was Professor of English Literature at Michigan State College. The family subsequently moved to Manhattan, Kansas, where David received his college training at Kansas State College.

In 1889 he began his career with the United States Department of Agriculture. He resigned in 1893 and went to Europe to study. There he met Barbour Lathrop, world traveler, who was to be his companion on many of his travels. Soon after the turn of the century he returned to the United States Department of Agriculture, where he continued until 1933. Since that time, however, he has collaborated with that department. Following is a résumé of his expeditions:

Dutch East Indies, 1895.
South Sea Islands, Siam, Australia, and New Zealand, 1896-97.
West Indies, South America, Egypt, Ceylon, Dutch East Indies, and New Guinea, 1898-1900.
Japan, Ceylon, China, and the Persian Gulf, 1901-02.
Africa, 1903.
Morocco, Dutch East Indies, West Africa, and the Caribbean, 1925-27 and 1932-33.
Philippines, Celebes, Java, Bali, and Moluccas, 1939-40.
Columbia, Panama, and Guatemala, 1941.
Guatemala and Yucatan, 1944.

In a recent letter, Mr. Fairchild listed the ten plants of which he is proudest; although he does not claim full credit for them, he finds satisfaction in the part he played in their introduction. They are as follows:

The **soybean**, from Japan in 1898.

The **tung-oil-tree** (*Aleurites fordi*), from Hankow, China, in 1904. Oil from the nuts of this tree is used extensively as a paint drier. There are now large plantations of the tree in Florida and Georgia.

The **hairy Peruvian alfalfa**, introduced from Peru in 1899. It is widely grown in California.

The **feterita variety of sorghum**, introduced from the Sudan in 1901. This is grown to a large extent in California and Arizona.

Many varieties of **dates** from Egypt, in 1901, and from the Persian Gulf and Bagdad in 1902. Some of the best date varieties grown in this country have resulted from these introductions.

The **nectarine**, from Quetta in Pakistan, in 1902.

Japanese bamboos, from Japan, in 1903.

Mango varieties from Bombay, India, in 1902.

Rhodes grass, now widely grown in Texas, sent from South Africa in 1903.

Many varieties of **flowering cherries**, from Japan in 1902. Fairchild advocated the planting of the famous cherries in Washington.

Although these men are among the great plant explorers, the reader is cautioned against thinking that they are the only outstanding collectors or even that they are the greatest. Some persons may quite possibly contest this choice of names. The only purpose of this article is to tell something of a few of the better-known men and of some of their introductions.

References

Those who wish to learn more of plant exploration and introduction may be interested in the following selected references:

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Farrer's Last Journey, by E. H. M. Cox. Published by Dulan, London, 1926.

George Forrest, by E. H. M. Cox. In *New Flora & Silva*, vol. 4, pp. 180-86. 1932.

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Plant Introductions of Reginald Farrer, by E. H. M. Cox. Published by New Flora & Silva Ltd., London, 1930.

Exploring for Plants, by David G. Fairchild. Published by Macmillan, New York, 1930.

Garden Islands of the Great East, by David G. Fairchild. Published by Scribner's Sons, New York, 1944.

The World Was My Garden, by David G. Fairchild. Published by Charles Scribner's Sons, New York, 1938.

The Garden of Asia, by Reginald J. Farrer. Published by Methuen, London 1905.

Ernest H. Wilson, by E. I. Farrington, Published by Stratford, Boston, 1931

Plantae Chinenses Forrestianae, by George Forrest. In *Notes from the Royal Botanic Garden*, Edinburgh, vol 17, pp. 1-406. 1929-30.

A Journey to the Tea Countries of China by Robert Fortune. Published by Murray, London, 1852.

A Residence Among the Chinese, by Robert Fortune. Published by Murray London, 1857.

Three Years Wanderings in the Northern Provinces of China, by Robert Fortune Published by Murray, London, 1847.

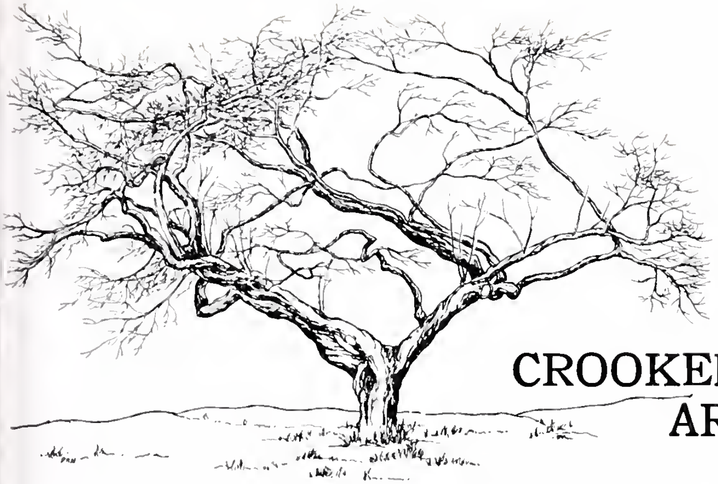
George Forrest, written and published by The Scottish Rock Garden Society Edinburgh, 1935.

A Plant Hunter in Tibet, by F. Kingdon Ward. Published by Jonathan Cape London, 1934.

Romance of Plant Hunting, by F. Kingdon Ward. Published by Edward Arnold, London, 1924.

China Mother of Gardens, by Ernest H Wilson. Published by Stratford Co. Boston, 1929.

A Naturalist in Western China, by Ernest H. Wilson. Published by Doubleday, New York, 1913.



CROOKED TREES ARE GOOD

Plants unconventional in form can serve as focal points in the garden. It is possible to train them

Stephen F. Hamblin

Condensed from *Landscape Architecture,* January, 1952

LOOK at trees as you go out of doors, just as you look at the sky, or listen to the songs of birds or the voices of men. Know the usual shapes of the usual trees and then seek out the unusual forms, to admire them as objects of contemplation; then try to figure out how they got that way.

Causes

We can arrive at roughly three categories of causes of freak outline to our trees. Some, as vase elm or weeping beech, are biological forms and can be reproduced by budding from a typical tree but will not be reproduced by seed. Some are local results of natural causes, physiological deformation, not to be propagated, and probably not constant if transported to good soil. Others are the direct result of the evil machinations of the mind of man (as lopped fences or sheared evergreens) or of the poetic instinct of man (as Japanese Bonsai).

Biological Forms

Many of the odd forms of our common trees are apparently natural. The American elm takes at least ten distinct forms, naturally. These may be called vase, umbrella, feathered, oak-tree, willow, irregular, weeping, contorted, pyramidal, and columnar. The ginkgo takes at least five forms — telegraph-pole, erect, big-shrub, fastigiate, and weeping. Several maples have erect and columnar forms; beech has two or more ways of weeping.

Some forms of unusual shape are purely freak seedlings at start, found in the wild or in the garden, and then by commercial intent are propagated by budding and sold to gardeners and thus perpetuated. These are biological forms and will continue their odd form as grafted plants. This is true of purple beech or weeping hemlock or dwarfed conifers. Many of our freak trees are direct exuberance on the part of Nature, and can be propagated truly by the thousands.

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Since only certain trees take naturally to freak forms, and many of our trees never depart from the usual (as in pin oak or horse-chestnut), the crop of naturally irregular trees will always be restricted in kind and quantity. As soon as a demand is made for this kind of tree shape, the nurseryman will have to propagate more widely than at present. Of the forms of the American elm only the vase form and the upright MOLINE are available. The others can be admired only as natural objects in place. The pyramidal ginkgo is now abundant in nursery rows, but the weeping is not visible.

Local Accidents

Other freak forms seem to be local accidents, brought about by the forces of nature. Such are wind-swept lines of red cedar, white pine, tupelo, or Monterey cypress, so placed that no imagination is needed to see and feel the pull of the winds upon them. Some are starved plants, as a paper birch growing in a crack in the ledge, or a white oak in a sand bank. These stunted, dwarfed, crooked trees are fighting starvation. Gray birch is often permanently bent in bow form from the weight of winter's snow—so also with red cedar or arbor-vitae on your lawn. If you want to save their dignity, shake off at once each heavy snowfall and bind them with wire to give them backbone.

Other freak trees are made by a landslide, a snowslide, a light forest fire, the grazing of cattle, old age (with conifers), or accidents caused by man.

These characters, being acquired, would not be transmittible by grafting, for grafts would probably go back to normal. Nor is it safe to dig the original crooked plant and transplant to your lawn. A crooked old pine would be a risk to move, and a stunted paper birch impossible to remove from its ledge. Deformed trees young in years would usually go normal in a new site, unless carefully pruned and trained.

Trained Forms

We come to the third method of production, taking the hint from Japanese Bonsai, and devoting our time, patience, and ingenuity to creating crooked, wind-swept, and weeping trees from seedlings which naturally grow straight.

Woody plants of unusual shapes, in Japanese effects, need not be in pots.

If a wisteria that may reach a height of 200 feet in normal growth can be pruned and trained to small-tree shape in a small garden, if a normal apple can be trained into an espalier of 10-foot height, surely other woody plants can be made to take on dwarf forms and unusual shapes, growing directly in the soil.

The plants chosen for this should be hard-wooded and slow-growing; and they should be planted in full sun and wind, in soil of only moderate fertility. Any strong summer growth is to be cut to two buds in autumn by shears, or pruned by fingers in summer. All these plants must have unusual irregular forms.

Helpful hints to keep down the natural vigorous growth:

Select naturally dwarfed forms (which still may fool you by growing to normal size later).

Graft or bud on dwarfing roots—as espalier apples on PARADISE stock, or on hawthorn or quince.

Find crooked trees in the woods or fields; since already well stunted by nature they will remain that way (unless too well fed).*

Withhold food and moisture to the degree that the plant can stand safely (as is done with potted plants), and feed little nitrogen.

Chop its roots every few years with the spade (as if repotting).

Give it a small pit of good soil, the surrounding soil mostly sand or gravel (not clay, unless for moisture-loving plants).

Clip, shear, twist, and bend, just as if these were potted plants.

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*Directions for transplanting may be found in PLANTS & GARDENS, Summer, 1952, page 147.—ED.

This crooked tree is carmine crab apple (*Malus atrosanguinea*).

In the end no more time would be taken to clip and train a tree to unusual shapes than to transform privet, forsythia, or arbor-vitae into a globe of no special interest, as is seen in many public places. If uninteresting or comical shapes can be made in place by man, surely the more unusual of the nature-trained forms can also be produced directly in the soil.

As samples of what we now have to work upon, unusual forms of the following can be found in many deserted gardens or can be man-made:

EVERGREEN

Japanese holly	(*Ilex crenata*)
lacebark pine	(*Pinus bungeana*)
spreading English yew	(*Taxus baccata repandens*)
weeping hemlock	(*Tsuga canadensis pendula*)

DECIDUOUS

Japanese maple	(*Acer palmatum*)
weeping beech	(*Fagus sylvatica pendula*)
tea crab apple	(*Malus hupehensis*)
weeping Higan cherry	(*Prunus subhirtella pendula*)

Justification

Why this sudden interest in crooked trees? The interest has been with us through the garden ages, partly sentimental, as the vogue for weeping willow or beech. But some of us still feel the call of an aged pine, a wind-swept red cedar, or snow-bent birch. An arcaded street of elms in New England is a treasured memory; a storm-bent white pine in my town holds my eye whenever I pass that way. We can note and enjoy unusual tree forms wherever they occur, and speculate as to how they got that way.

In modern garden design an object of interest is often required as turning point or focus. In addition to sculptured objects of stone or metal, a living plant of unusual or arresting form could be used.

With our modern houses of limited lot area and low roof line, trees of normal height are out of scale. Even big shrubs are too bulky. Since trees of irregular form may also be dwarf in height and reduced in spread, these unusual forms may fit the dimensions of the lot better than trees of normal size. If a home lot has room for but one tree, this should be special and perhaps cost more than the average. It has greater inner values also. As a living object in a court or small terrace I suggest a tree of special and restricted shape.

Against the stretch of blank wall on many modern homes I would place a trained dwarf tree, either espalier or free standing, that its form and shadows could be contrasted to the plain and even surface of that wall. Thus what was once playful Nature may now be admitted into the art of man.

WORTH READING

A SELECTED LIST OF RECENT NONTECHNICAL BOOKS, MAGAZINE ARTICLES, AND EXPERIMENT STATION BULLETINS

General

PLANTS, MAN AND LIFE, by Edgar Anderson. Published by Little, Brown, Boston, 1952. 245 pages, $4.

Gives a new insight into the green world and discusses the influence of plants on man, and man's influence on plant development.

PLANTS OF THE BIBLE, by Harold and Alma Moldenke. Published by Chronica Botanica, Waltham, Mass., 1952. 328 pages, $7.50.

Alphabetically arranged résumé of present-day knowledge of Biblical botany, including factual lore, descriptions, and index to Bible verses.

THE STORY OF TREES, by Ferdinand C. Lane. Published by Doubleday, Garden City, New York, 1952. 384 pages, $5.

A combination of ancient myths, historical anecdotes, physiology, and economic uses of trees. The history, life, and character of the earth's woods.

AMERICA'S CROP HERITAGE, by Nelson Klose. Published by Iowa State College Press, Ames, Iowa, 1950. 156 pages, $3.50.

The history of foreign plant introduction by the Federal Government.

WHAT'S INSIDE OF PLANTS? by Herbert S. Zim. Published by Morrow, New York, 1952. 32 pages, $1.75.

A picture book of botany, planned for parents and children to read together, explaining the work of roots, stems, leaves, seeds, etc.

PLAY WITH LEAVES AND FLOWERS, by Millicent E. Selsam. Published by Morrow, New York, 1952. 64 pages, $2.

A junior book about plant movements and their causes, with experiments and illustrations to explain them.

AN INTRODUCTION TO WILD FLOWERS, by John Kieran. Published by Hanover House, Garden City, N. Y., 1952. 77 pages, $2.50.

Well illustrated elementary guide to common flowers of woods, fields, and swamps.

GREEN FINGERS and other poems, by Richard Arkell. Published by Harcourt, Brace, New York, 1952. 118 pages, $2.

A collection of gay, amusing, and sometimes philosophical verses about gardeners.

MAKING LAND PRODUCE USEFUL WILDLIFE, by W. L. Anderson. U. S. Department of Agriculture Farmers' Bulletin 2035. Oct., 1951. 29 pages, 15¢.

How to have a successful community on the land by maintenance of a desirable biological balance.

OUR AMAZING BIRDS, by Robert S. Lemmon. Published by the American Garden Guild and Doubleday, Garden City, New York, 1952. 239 pages, $3.95.

Little-known facts about the private lives of 102 birds. Historic breeding grounds, range, intelligence. Drawings.

MIGRATION OF BIRDS, by Frederick C. Lincoln. Published by Doubleday, Garden City, New York, 1952. 102 pages, $1.

Distribution and seasonal movements of North American birds from the Arctic coast to the pampas of Argentina.

Economic Plants

ECONOMIC BOTANY, second edition, by Albert F. Hill. Published by McGraw-Hill, New York, 1952. 560 pages, $7.

An illustrated textbook of useful plants and plant products throughout the world.

REGISTER OF NEW FRUIT AND NUT VARIETIES, 1920-1950, compiled by R. M. Brooks and H. P. Olmo. Published by University of California Press, Berkeley and Los Angeles, 1952. 206 pages, $3.

Verified information on origin and characteristics, of value to growers.

THE HOME GARDEN BOOK OF HERBS AND SPICES, by Milo Miloradovich. Published by Doubleday, Garden City, New York, 1952. 236 pages, $2.95.

History, legends, and uses of foods. Cultivation and harvest. Preparation of fragrant sachets and lotions.

PLANTS FOR MAN, by Robert W. Schery. Published by Prentice Hall, New York, 1952. 564 pages, $7.50.

Well illustrated text on plant products used industrially as lumber, fiber, extracts, resins, and foods.

Landscaping

PICTURE PRIMER OF DOORYARD GARDENING, by Margaret O. Goldsmith. Published by Houghton Mifflin, Boston, 1952. 48 pages, $2.

Full-color illustrations and text demonstrate how to plan, plant, and manage gardens built close to the house, for beauty and pleasure.

THE PORTABLE GARDEN. A Sunset Book, published by Lane, Menlo Park, California, 1952. 64 pages, $1.

How to use clay pots, tubs, hanging baskets, and window baskets to grow annuals, perennials, vines, bulbs, etc., for mobility in the garden.

BEAUTIFY YOUR HOME GROUNDS, by Peter Rhodes. Published by Homecrafts, New York, 1952. 90 pages, $1.50.

Practical booklet on construction of walks, terraces, fences, paths, etc. Plot plans and suggested planting designs. Ink drawings.

HOW TO BUILD WALLS, WALKS, PATIO FLOORS. A Sunset Book, published by Lane, Menlo Park, California, 1952. 96 pages, $1.50.

Making use of stone, concrete, adobe bricks, gravel, tanbark, etc. Well illustrated with photographs and drawings.

SUNSET PATIO BOOK, published by Lane, Menlo Park, California, 1952. 174 pages, $3.

How to plan; remodel an old one or get more use out of the one you have.

Horticultural Practices and Gardening

MELADY GARDEN SERIES, by John Hayes Melady. Published by Grosset and Dunlap, New York, 1952. Four books, about 150 pages each, $1.50 each.

Illustrated manuals on Flowers, Fruits, Vegetables, and Lawns. Step-by-step information for specific plants; culture; and care.

CHEMICAL WEED CONTROL IN HORTICULTURAL CROPS, by D. D. Hemphill, A. E. Murneek, and J. E. Smith, Jr. University of Missouri (Columbia) Agricultural Experiment Station Bulletin 568, March, 1952. 28 pages.

Methods, equipment, and sprays to use on lawns, ornamentals, and vegetables.

MODERN GARDENING, by P. P. Pirone. Published by Simon and Schuster, New York, 1952. 370 pages, $3.50.

Guide to agricultural uses of chemistry's "miracle drugs." Foliage feeding, weed sprays, and growth hormones.

GROWING PLANTS UNDER ARTIFICIAL LIGHT, by R. Milton Carleton. In *Horticulture*, Sept., 1952. 2 pages.

What the plants need; what plants to grow and where to grow them; maintenance.

SUNSET PRUNING HANDBOOK, by Roy L. Hudson. Published by Lane, Menlo Park, California, 1952. 80 pages, $1.50.

Well illustrated book of instructions; for trees, shrubs, and vines.

Pests and Diseases

THE GARDENER'S TROUBLE SHOOTER, by Victor H. Ries. Published by Sheridan House, New York, 1952. 320 pages, $3.50.

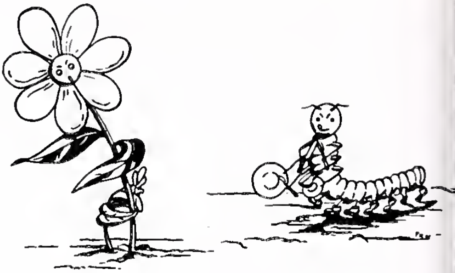
Effects of soil, temperature, climate, etc., on plant growth. How to diagnose specific troubles, and applicable remedies for disease and pest control.

IMPORTANT TREE PESTS OF THE NORTHEAST, second edition, by the Society of American Foresters. Published by Evans, Concord, N. H., 1952. 190 pages, $2.

A manual of insect and disease damage, with suitable remedies, made practical for the care of garden and forest trees.

BACKYARD MONSTERS IN COLOR, by Paul A. Zahl. In *The National Geographic Magazine,* Aug., 1952. 25 pages.

Close-up pictures of many garden insects; interesting facts about their life habits.



CONTROLLING NEMATODES IN THE HOME GARDEN, by J. R. Christie and A. L. Taylor. U. S. Department of Agriculture Farmers' Bulletin 2048, Sept., 1952. 12 pages, 10¢.

What these pests do and how to combat them by fumigation.

Soils and Fertilizers

OUR GARDEN SOILS, by Charles Kellogg. Published by Macmillan, New York, 1952. 232 pages, $4.

A complete soil guide for the home gardener. What soil is; acidity, nutrients; management and some planting techniques. List of selected plants classified according to their soil requirements.

MANURES AND FERTILIZERS, by Sir James A. Scott Watson. Published by Chemical Publishing Co., New York, 1952. 95 pages, $2.50

Although designed for farmers, this survey contains valuable information for the home gardener. It is divided into three parts: organic manures available from farm and industry, inorganic fertilizers, and evaluation and application.

SOIL MANAGEMENT IN GARDENS, PARTS I AND II, by Charles E. Kellogg. In *The Garden Journal of the New York Botanical Garden,* March-April and May-June, 1952. 6 pages.

Part I: A nontechnical article telling of what soils are made; how to explore them for potentialities; how to control water.

Part II: Clarification of soil acidity and alkalinity; plant nutrients; organic matter versus chemicals; earthworms.

SOIL MICROBIOLOGY, by Selman A. Waksman. Published by Wiley, New York, 1952. 356 pages, $6.

Life in the soil. Discusses the numerous biological, physical, and chemical processes in which microorganisms are involved.

Trees, Shrubs, and Vines

THE BEST LOVED TREES OF AMERICA, by Robert S. Lemmon. Published by Doubleday and American Garden Guild, Garden City, New York, 1952. 254 pages, $3.50.

Full descriptions of fifty-nine native trees; where and how they grow; economic uses. Well illustrated.

ILLUSTRATED GUIDE TO TREES AND SHRUBS, by Arthur H. Graves. Published by the author, Wallingford Conn., 1952. 240 pages, $4.

Compact text on northeastern woody plants, native and naturalized, with keys to winter and summer characteristics. Well illustrated.

AMERICAN TREES, by Rutherford Platt. Published by Dodd, Mead, New York, 1952. 256 pages, $3.50.

Includes trees of all parts of the United

States, with nontechnical descriptions and unusual facts. Color photographs and drawings.

TREES AND SHRUBS IN EASTERN NORTH AMERICA, by Benjamin Blackburn. Published by Oxford University Press, New York, 1952. 358 pages, $6.

Nonillustrated volume of keys to native and cultivated woody plants, exclusive of conifers.

THE TREES OF LONG ISLAND, by George H. Peters. Published by the Long Island Horticultural Society, 10 Westminster Street, Massapequa, L. I., N. Y., 1952. 63 pages, $1.

History, distribution; lists of first "Big Tree" census, with illustrations.

TREES AND THEIR CARE, by P. P. Pirone. In *Flower Grower,* March, 1952. 6 pages.

On the choice, planting, and fertilizing of trees. Detailed tables on tall and small-growing trees, giving height, soil requirements, and outstanding features.

THE SHRUBS OF PENNSYLVANIA, by William C. Grimm. Published by Stackpole, Harrisburg, Pa., 1952. 522 pages, $5.

Designed for the layman, with clear descriptions and illustrations. Keys to summer and winter characteristics.

FLOWERING SHRUBS OF LATE SUMMER, by E. L. Kammerer. *Morton Arboretum Bulletin of Popular Information,* Sept., 1952. 3 pages.

Sweet pepperbush, shrub lespedeza, hardy lilac chaste-tree, cut-leaf chaste-tree, and blue-mist bluebeard (hybrid).

NEW RHODODENDRONS: FOR THE NORTHEAST, by G. G. Nearing; **FOR THE NORTHWEST,** by Leonard F. Frisbie. In *Flower Grower,* April, 1952. 9 pages.

Discussion, with descriptions of new hybrids adapted to each of these areas.

THE AZALEA HANDBOOK, by Frederic P. Lee and others. Published by the American Horticultural Society, Washington, D. C., 1952. 148 pages, $2.35.

Flower and leaf descriptions of named varieties; recommended varieties in regional areas; culture; pests.

ANYONE CAN GROW ROSES, by Cynthia Westcott. Published by Van Nostrand, New York, 1952. 147 pages, $2.

The home gardener's complete guide to successful rose culture.

MODERN ROSES IV, J. Horace McFarland Co., and the American Rose Society. Published by McFarland, Harrisburg, Pa., 1952. 361 pages, $7.50.

A uniform descriptive list of all roses in commerce or of historical or botanical importance.

ROSE PROPAGATION, by John G. Stropkey. In *American Rose Magazine,* July, 1952. 3 pages.

Step-by-step directions for propagation of root stock, and the technique of budding scions on it.

HARDY VINES IN VARIETY, I AND II, by E. L. Kammerer. *Morton Arboretum Bulletin of Popular Information,* Oct. and Nov., 1951. 8 pages.

Discussion of the merits of many kinds

Propagation

PLANT PROPAGATION, by E. J. King. Published by Farrar, Strans, and Young, New York, 1952. 264 pages, $4.

Clear and nontechnical description of the methods of seeding and vegetative propagation, including cuttings, grafting, budding, and natural propagation.

SPHAGNUM MOSS GOES MODERN, by William Gilman. In *Nature Magazine,* March, 1952. 3 pages.

How to sift this sterile moss for use as a seed-growing medium.

HOW TO RAISE TRAILING ARBUTUS FROM CUTTINGS, by Montague Free. In *The Home Garden,* July, 1952. 4 pages.

Vegetative propagation of a plant that is difficult to transplant from the wild.

GROW DESERT PLANTS FROM SEED, by J. A. Jump. In *Flower Grower,* Nov., 1952. 3 pages.

How to do it; what to raise; plants that need little attention.

PROPAGATION OF ORNAMENTAL PLANTS, second edition, by John V. Watkins. University of Florida (Gainesville) Experiment Station Bulletin 150, April, 1952. 56 pages.

Description of methods for cuttings, division, budding, grafting, and seeding. Care and management.

Indoor Gardening and Flower Arrangement

HOW TO GROW BETTER HOUSE PLANTS, by Esther Grayson. Published by Hydroponic Chemical Co., Copley, Ohio, 1952. 62 pages, $1.

A concise and practical handbook on selection, care, and more efficient display. Lists about seventy-five different plants.

DECORATING WITH HOUSE PLANTS, by Ruth Gannon. Published by Studio-Crowell, New York and London, 1952. 136 pages, $5.

How to select and use house plants suitable in home growing conditions; bulb forcing, seeding, soils, care, and propagation.

A FUCHSIA SURVEY, by W. P. Wood. Published by Farrar, Straus, and Young, New York, 1952. 170 pages, $2.75.

Handbook covering history, culture, care, variety selection, and hybridizing techniques.

HOW TO GROW RARE GREENHOUSE PLANTS, by Ernest Chabot. Published by Barrows, New York, 1952. 182 pages, $4.

Detailed culture information for 260 flowering plants, with descriptions and some illustrations.

MAKING CORSAGES AT HOME, by Dorothy Biddle and Dorothea Blom. Published by Barrows, New York, 1952. 64 pages, $2.50.

Step-by-step instructions for using materials from the home garden.

FLOWER ARRANGEMENTS FOR ALL OCCASIONS, by Marie Johnson Fort. Published by Rinehart, New York, 1952. 237 pages, $8.50.

Numerous illustrations of flower arrangements. Many of them in period style; Japanese, fruit, and traditional forms.

THE COMPLETE BOOK OF DRIED ARRANGEMENTS, by Raye Miller Underwood. Published by Barrows, New York, 1952. 193 pages, $4.95.

Techniques of obtaining materials and drying them for arrangements, pictures, and plaques.

Garden Flowers and Lawns

BEGINNER'S HANDBOOK ON CHRYSANTHEMUM CULTURE, by Elmo Caruthers and others. A supplement to *The Bulletin of the National Chrysanthemum Society.* Sept., 1952. 40 pages.

Complete guide, covering soil, care, propagation, diseases, and exhibiting.

THE AURICULA, by Rowland Biffen. Published by Cambridge University Press, New York, 1951. 164 pages, $3.

Handbook giving history, origin, culture, and hints on breeding.

WILD FLOWERS FOR YOUR GARDEN, by Helen S. Hull. Published by Barrows, New York, 1952. 280 pages, $4.95.

Where and how to use them; raising them from seed or cuttings; gathering and planting; numerous lists of plants to choose.

YOUR GUIDE TO A GREENER LAWN, Geoffrey S. Cornish. Published by the Massachusetts Horticultural Society, Boston, 1952. 63 pages, 75¢.

A practical and well illustrated handbook; ready reference for maintenance, establishing new lawns, pest and weed control, and tools.

ESTABLISHING THE NEW LAWN, by Albert E. Cooper. Pennsylvania State College (State College, Pa.) Agricultural Extension Service Circular 407, Sept., 1952. 9 pages.

Simple step-by-step instructions; illustrations.

WITHIN THE BROOKLYN BOTANIC GARDEN

University of British Columbia photo
T. M. C. Taylor

FIRST AWARD OF THE C. STUART GAGER FELLOWSHIP

In March 1953 the Botanic Garden will welcome Professor T. M. C. Taylor of the University of British Columbia, to whom the C. Stuart Gager Fellowship has been awarded. Dr. Taylor is Director of the Botanical Garden at the University—just now beginning to be developed—and is therefore particularly interested in botanic garden organization and collections. He will observe procedures at other botanic gardens and arboreta in the eastern states, as well as here. As a special project, he will make a survey of the outdoor plantations at the Brooklyn Botanic Garden.

This appointment is particularly significant because Dr. Taylor is the first holder of the fellowship established in 1944 as a memorial to Dr. C. Stuart Gager, Director of the Brooklyn Botanic Garden from its founding in 1910 till his death in 1943. Friends and business and professional associates, 445 of them, established this fund to perpetuate his memory. The fellowship is for research in botany, horticulture, or botanical education and is awarded as the income on the fund permits.

OTHER FELLOWSHIPS

Through the generous foresight of interested groups and individuals, bequests and current gifts have been made to establish other fellowships for educational and scientific study at the Botanic Garden. One such fund was inspired by the twenty-fifth anniversary celebration of Miss Ellen Eddy Shaw's work with children at the Garden (1938). The Woman's Auxiliary, desirous of perpetuating Miss Shaw's teaching philosophy, made possible the initial gift which has grown into the Ellen Eddy Shaw Fellowship Fund. The Shaw Fellowship is available from time to time to young college graduates with an interest in horticulture or elementary education. They are afforded an opportunity to participate in the Garden's educational program, and in turn give of their own experiences to continue its progress. Miss Shaw, now Curator Emeritus, started her program in 1914, to give city children an opportunity to learn about the plant world through popular gardening, greenhouse, and classroom experiences. This fellowship has been awarded four times, and three of the fellows have remained at the Garden as instructors.

At present, the Garden has three fellowship holders on its staff, one of whom is Peter K. Nelson, from the University of Wisconsin. He is studying seed dormancy by means of embryo culture, also the effect of cold treatment on dormancy of woody plants. Donald G. Huttleston, a Cornell University graduate, holds a fellowship made possible by the Marion Louise Peters bequest. He is part-time curator of the herbarium and is completing a thesis for his Ph.D. degree at Cornell. The new Woman's Auxiliary fellowship for plant breeding is held by Mrs. Evamaria Sperber, recently of the Technical University of West Berlin, Germany. J. L. F.

INDEX TO VOLUME 8, 1952

Bold face *page numbers indicate illustrations. An asterisk (*) indicates color.*

abelia **119**, 317
Abies 143, 318
Acer 11, 13, 121, 325
Achillea 200, 204, 233, 237
Actinea 226
actinella **227**, 228
actinidia 320
adders-tongue 229
aerifying device, lawn **281**
Aesculus 11, 12
Aethionema 201, **208**
African-violet 15, 302
ageratum 15
Ahlgren, Gilbert H. 42
Ailanthus 11, 13
air layering **298-300**
Aleurites 322
alfalfa 48, 322
algae 57
alkanet 261
alligator-weed 56
Allium 204, 235, **247**-248
almond 119
  flowering 9
alpen-clocks 240
alpine-azalea 252
alpine-daisy 229
alpine-lily **227**-228
Alternanthera 56
alum-root 228-229, 260
Alyssum **182**, 200, 202-203, 215, **224***, 237, 243, 260
amaryllis 235
American Nurseryman 311
American Rock Garden Society, Bulletin 309
Anchusa 261
andromeda 136
Andromeda 309
Androsace 201, 206-**207**, 227, 240, 321
Amemone 204, 206, 218, 261, 321
angels-tears **211**
Antennaria 227
Anthriscus 248
aphid **265** (see correction at end of index)
apple 6, 14, 17, 120-121, 123, **162-163**, **168-169**, 170, 172, **173**, 282-283, **285**, **287**, **289**, 305, 313, 324
  crab (see crab apple)
  hormones for 6, **26-28**, 101
  ripen picked green 6, 28
aquarium for terrarium **307**
Aquilegia 201, 207-**208**, 219, **221**, 229
Arabis **183**, 199, **202**-203, 228, 233, 236-237, 260
arbor-vitae 15, 49, 139-**140**, 143, 324-325
arbutus, trailing 305
Arctostaphylos 244, 260
Arenaria 199, **200**, 205, 215, 227, 260
Arethusa 309
Arisaema 220-**221**
Armeria **181**, **203**-204
arnica 229
Aronia 9, 283
Artemisia 233, 260
ash 11-12
asparagus 49
asphodel, bog- 309
Asplenium 223, 307
aster 205, 208-**209**, 260, 317
astilbe 209
Atamasco-lily **232**
aubrieta 201, **205**-206, 237, **258**, 260
Aucuba 299
auricula **207**
autumn-crocus 245
avens 200, 229, 260
Avery, George S., Jr. 1, 4, 14, 26, 113, 177, 275
azalea 9, 15, **178**, 214, 245, 297, 317
  alpine- 252

bacteria 289
balsam, liver- 201, 237
bamboo 322
bananas, picked green, hasten ripening of 6, 28
Banta, Eldon S. 115
barberry 15, 123, 136-137, 316, 318-319
barley 48
Barton, Lela V. 262
basil 175, 248
basket-of-gold **224-225***
bayberry 15
Baylis, Douglas 276
beans and hormones 36-**37**
bearberry 244, 260
beard-tongue 201, 204, 228-229, 250, 264
beauty-berry, pruning **122**
beauty-bush 15, 123, 315
beech 125-126, 323, 325
beet 41, 48, 291
beetle **266-267**, **269**
begonia 15, 176, 302
bellflower 201, 205, 209, 228, 238-239, 245, **254-257**, 260, 263, 319
bent grass 42, 280-281
Berberis 123, 316, 318-319
Bergenia **224-225***
Bermuda grass 280
Better Homes & Gardens 276
bindweed 260
birch 145, 324-325
bishops-cap 219-220
bistort 226
bitter-root 263-264
bittersweet 187
blackberry 155-158
bladder fern 224
bleeding-heart 260-261, 317
blister beetle **267**
blister-cress 237
bloodroot **219**
bluebells 220, 228-229
blueberry **172**, 251
blue grass 40, 42, 44-45, 279 280
Bockes, Olga **306**
bog-asphodel 309
bog garden 309-**310**
bog-laurel 229
borage (*Borago*) 248
box **129**, 316
boxwood 15, 127, 297
bramble fruits pruned 155-**158**
brass-buttons 233
breadroot 228
breeding, plant **35-39**
Briner, Viola 184
brittle fern **224**, 228
Brodiaea **231**, 235
Brooklyn Botanic Garden
  bog **310**
  cherry blossom festival **112**
  fellowships **331**
  flower show exhibit **175-176**
  poisonous plant 271
  Rose Garden trellis **274**
  tropic plants bloom **270**
  winter evening **winter cover**
broom 245, 260
broom crowberry 253
Bruckenthalia 252
brush control 53-55, 107-109
budding upside down **288**
Buddleia 119, 316, 318
buds, leaf and flower **169**
bugloss 261
bugs **263-267**
Burdett, James H. 154
burnet 247

urning-bush 121
uttercup 206, 229
utterfly-bush 15, 119, 318
uxus 129, 316
abbage, Chinese- 291
actus 192, **210-211**
alifornia rock garden **236**
alla **309-310**
allicarpa, pruning **122**
allirhoe 260
alluna 245, **250**, 252
alochortus 263-264
alopogon 309
altha 229
alypso 309
amass (*Camassia*) 264
amellia 297, 302
ampanula 201, 205, 209,
  215, 220, 228, 238-239,
  245, **254-257**, 260, 263,
  319
ampion 201, 205, 237
ampsis 119
amptosorus 224, 307
andytuft 199, 203, 237,
  243, 260
antaloupe 36
anterbury bell 255, 305
ape-jasmine 232
ARDINELL, H. A. 162, 167
ARLETON, R. MILTON 293
arnation 15
arrot 40, 48, 290-291
astanopsis 320
astilleja 228
atalpa 11-12, **124**
atchfly 199, 205, 237
atharinea 307
ats-paw 227
eanothus 260
edar, red 50, 140, 324-325
elandine, lesser 206
erastium **183**, 227
eratostigma 234, 261
HADWICK, L. C. 10
haenomeles 119, 123
hamaecyparis 250
haulmoogra-tree 320-321
Cheiranthus 229
cherry 172, 282-284, 286,
  311, 314, 320-322, 325
  blossoms, longer life 7-9
  -laurel 136, 320
chervil 248
chestnut, horse- 11-12, 324
chestnut, water- 56-57
chickweed 40, 43, 107, 227
chigger **269**
Chile-star 235
Chimaphila 306
chiming bells 228
Chinese-cabbage 291
chinquapin 320
Chionodoxa 234-235, 245
chive 204, **247-248**
chokeberry, 9, 283
Christmas fern **223-224**
Christmas greens, keeping
  leaves on 9
Christmas-rose 215-**216**, 234
chrysanthemum 15, 176, 206,
  260, 314, 316
  prune, disbud **133-135**
inquefoil 200, 204, 206,
  229
Cirsium **226**-227
citrus 185
city rock garden **241-245**
Claytonia **218**-219, 228
clematis 15, 119
click beetle **269**
clipper for hedges **118**
clover 107, 229
club-moss 307
Coccothrinax 270-**271**
coffee-tree, Ky. **11, 13**
COLBY, A. S. 155, 159
Colchicum 245
coleus 15
columbine 201, 207-**208**, 219,
  221, 229
Convolvulus 260
Corema 253
corn 290
Cornus 123, 315
Cotinus 121
cotoneaster 15, 119, 137, 232,
  245, 252, 283, 285, 319
cotton 41, 48
Cotula 233
Cotyledon 260
cowberry 253
crab apple 9, 11, 13, 283,
  286, 315, 318, **325**
  flowering, evaluate **311-313**
crab grass 41, 43-45, 48, 109-
  110, 279-281
crag herbicide 1 **49-50**
cranberry-bush 122
CRANE, JULIAN C. 21
cranesbill 209, 234, **237**-238,
  261
crape-myrtle 15
crassula 15
Crataegus 283, **319**-320
CREECH, JOHN L. 298
cress
  blister- 237
  rock- **183**, 199, **202**-203,
    233, 236-237, 260
  stone- 201, **208**
crocus 235, **243**-245, 247
  autumn- 245
crooked trees good **323-325**
crowberry 253
  broom 253
cucumbers on fence **154**-155
currant pruning **159-160**
cushion-pink 227
cuttings
  rock plants **258-261**
  rooting of **14-15**, 102
cyclamen 209, 239-**240**
Cydonia 283
Cymbalaria 233
cypress 185, 250, 324
Cypripedium 220-**221**, 309
Cystopteris **224**, 228
daffodil **211, 213**, 216, 304
  fall- 235, **243**, 245
dahlia 15, 176
dahoon 297
daisy 176, 187
  alpine- 229
  globe- 209
dandelion 40, 43, 44
DANIELSON, L. L. 51
Daphne **183**, 260, 297
DARLING, RICHARD J. 249
date 322
Davidia 315
DAVIDSON, RALPH H. 265
  (correction, end of index)
DEPETRIS, VINCENT R. 133
design, rock garden **190-193**
deutzia 120, 123, 317
Dianthus **200**-201, 204, 209,
  215, **237**-238, 260
Dicentra 218-**219**, 260-261,
  317
dittany of Crete 246
Dodecatheon 261
dogs-tooth violet 229
dogwood 123, **148**, 299-300,
  315
"donkey's smell" 208
double working **284-285**
dove-tree 315
Draba 202, 228, **263**-264
dryad (*Dryas*) 199, 208, 229
Dryopteris 222-223
Dutchmans-breeches **219**
dwarf-forget-me not 227, 240
dwarf, make plants **282-289**
edges for lawns **276-278**
Eichhornia **56**
elder 123
elm 122, 320, 323-324
Empetrum 253
EMSWELLER, S. L. 35
ENGEL, RALPH E. 42
Enkianthus 299
epimedium **233**-234
Erica 232, 245, 252
Erigeron 229, 235
Erinus 201, 237
Eritrichium 227, 240
Erodium 201, 209, **239**-240
ERSKINE, DONALD 10
Erysimum 237
Erythronium 229
euonymus 9, 15, 121, 123,
  125, 211
Eupatorium 222
evening-primrose 200, 261
evergreens, prune **136-143**
  trimmings, window boxes
    143
Fagus 325

Fairchild, David 321
fall-daffodil 235, **243**, 245
false-spirea 315
fan-style pruning **167-168**
Farrar, Geraldine 304
Farrer, Reginald 317
Faust, Joan Lee 282-283
fern 217, 222, 224, 307
fescue 42, 44, **215**, 217, 280
Festuca **215**, 217
figs and hormones **21-25**, 101
fir **141**, **143**, 318
firethorn 120, **136-138**
fleabane 229, 235
flea beetle **266**
flower bud production by trees, shrubs **169-173**
flower diagram **35**
Flower Grower 279, 306
foam-flower 219-220, 223
forget-me-not 208, 260
  dwarf- 227, 240
Forrest, George 318
forsythia 15, 123-124, **170-171**, 317, 325
Fortune, Robert 316
fragile fern **224**
frangipani 271
Frankenia 240
Fraxinus 11-12
fruit trees, pruning **115-124**, **152-153**, **161-173**
fruit, undesirable, prevention **10-13**, 102
fuchsia 15, 236

Gager fellowship 331
Galanthus 235, **242**
Gardenia 232
garden, meaning to me, **304**
garden, rocks in **178-183**
garland flower **183**
garlic, wild 48, 50
Garson, Greer **112**
Gaston, H. P. 164
Gaultheria 220, **222**, 260, 307, 319
Gaylussacia 253
Genista 245, 260
gentian (*Gentiana*) **194-195**, 206, 209, **224-225***, 229, 240, 260, 264, 318-319
geranium **15**, 176, 236
  strawberry- 199
Geranium 201, 209, 220, 234, 237-238, 261
germander **180**, 252
germination rock plants **262**
Geum 200, 229, 260
Ginkgo 11, 13, 323-324
gladiolus 50
Gleditsia **10-12**
globe-daisy 209
globe-flower **229**, 261, 319
Globularia 209
glory-of-the-snow **234-235**, 244-245
golden-bells **123**, **317**
goldenrod 187
golden-tuft **182**, 200, 203, **224-225***, 243, 260
goldflower 226
Goodyera 222
gooseberry pruning **159-160**
grafted plants, pruning **174**
grapefruit 6, 30
grape-hyacinth **235**, 245
grass 40, 42, 46, 48, 52, 109, 187-188, **215**, 217, 279-281, 310, 322
  for better lawns 279-281
  ornamental **215**, 217
grass-pink 309
Grau, Fred V. 279
gravity and hormones **5**
greenhouse, for you **301-303**
gromwell **237-238**, 260
ground-pine 306
groundsel **224-225***, 229
grub **268**
gum, sweet 13
Gymnocladus 11, 13
gypsophila 199, 205, 245, **258**, 260

Habenaria **309**
Hamblin, S. F. 202, 323
hardiness, gambling on 295
  zones **297**
harebell 220, 228, 256
Harper's Magazine 289
Hassan, Elsie N. 230
hawthorn 125, 283, 285, **319-320**, 324
heading back a shrub **121**
heath 15, 195, 232, 245, 252
  mountain- 253
  spike- 252
heather 15, 214, 245, **250**, 252
Hedera 199, 211, 217, 233
hedges, trimming **125-129**
Helianthemum 200, **238**, 250, 260
Helleborus 215-216, **231**, 234
hemlock **128**, 282, 323, 325
hens-and-chickens 201
hepatica 219-220, **223**, 306-308
herb-Robert 220
herbs, rock garden **246-248**
heronsbill 201, 209, 239-240
Heuchera 228-229, 260
hills-of-snow 120
Hippeastrum 235
Hitchcock, A. E. 46
hoarhound 247
holly 9, 15-16, **126**, 136-138, **297**, **300**, **317**, **325**
  berries, no pollination **16**
Home Garden, The 295, 301
honey-locust **10-12**, 127, 129
honeysuckle 121, 123, 125, **171**, 305, 317
hormones
  primer **4-6**
  uses in gardening **6-111**
horse-chestnut 11-12, 324
Horsford, William C. 218
Horticulture 304
houseleek **201-203**, 205, 21
  224-225*, 260
Howlett, Freeman S. 18
huckleberry 253
hunters, plant 314
Huttleston, Donald G. **31**
hyacinth 235
  grape- **235**, 245
  water- **56-57**
Hyacinthus 235
Hydnocarpus 321
Hydrangea 15, 120
Hymenoxys **227**-228
Hypericum 200, 215, 251
  260, **263-264**

Iberis 176, 199, 203, 20
  215, 237, **243**, 260
Ilex 9, **126**, **138**, 297, 31
  325
impatiens 176
incarvillea 321
iris 202-203, 208, 216-21
  234, 238, **242-244**, 30
  314
ivy 199, 211, 217, 233, 29
  Kenilworth- 233
  poison- and 2,4-D **sprin**
  cover, 41, **46**-48, 109

Jack-in-the-pulpit 218, 22
  221
Jacobs-ladder 228
jasmine **317-318**
  cape- 232
  rock- 201, **206-207**, 227
  240, 321
Jasminum **317**-318
Johnson grass control 4
  48, 52
jonquil 235
June grass 46
juniper 15, 49, 139-140, 31
Juniperus 49-50, 318

Kalmia 229
Kelly, George W. 225
Kenilworth-ivy 233
Kentucky coffee-tree 11, 13
Kerria **2, 114, autumn insid**
  front cover, 273
Kieran, John **112**
King, Lawrence J. 49
kings crown 192, 229
Kiplinger, D. C. 258
knotweed 48
Kolkwitzia 123, 315
Kraus, E. J. 161, 166
Krilium and its rivals 289
lace bug **267**
lady-slipper 220-**221**, **309**

Landscape Architecture 323
andscape, rock garden in **184-189**
antana 15
arkspur 305
aurel
  bog- 229
  cherry- 136, 320
  mountain- 136-137
Lavandula 201, 232, **246-247**, 252
avender 15, 201, 232, **246-247**, 252
  -cotton 232, **248**, 260
awns
  aerifying device **281**
  better grasses for 279-281
  borders, edges **276-278**
  weed-free **42-45, 91**
eaf hopper **266**
Leiophyllum **251**-252
emon 30
Lenten-rose 215, 231, 234
lettuce 41, 175, 291
  wild 40
Leucocoryne 235
leucothoe 120
Lewisia 201, 211, 228, 263-264
lichen 192-193
light and hormones 5
Ligustrum 120, 123
lilac 9, 15, 50, **119**, 122-123, **170, 174, 283**
  summer- 316
Lilium 315, 321
lily **38-39**, 305, 315, 321
  alpine- **227**-228
  Atamasco- **232**
  Mariposa- 263-264
  snow- 229
  zephyr- 232, 235
Linaria 201
linden 125
Liquidambar 13
litchi culture profitable 34
Lithospermum **237**-238, 260
little red elephant **228**-229
liver-balsam 201, 237
liverleaf 219, 223
Lloydia **227**-228
lobelia 218
locust, honey- **10-12**, 127, 129
Loiseleuria 252
Longenecker, G. William, Professor of Horticulture, University of Wisconsin at Madison 139
Lonicera 121, 123, 317
lousewort **228**-229
Lovelock, E. B. 194, 254
Love, William B. 144, 147
lychee 34
Lychnis 205
Lycopodium 306-307
Macleaya 189
madwort 202, 237, 260
magnolia 9
mahonia 120, 136
maidenhair-tree 11, 13
maidenhair-vine 232
Majorana 246
maleic hydrazide 48
mallow, poppy- 260
Malus 11, 13, 120-121, 123, 283, 286, **311-313**, 315, 318, **325**
Manchester, Harland 289
mango 322
maple 11, 13, 121, 125-126, 145, 174, 323, 325
marigold 176
  marsh- 229
Mariposa-lily 263-264
marjoram 233, 246
Marrubium 247
marsh-marigold 229
Marth, Paul C. 7
Mazus **230**, 233
meadow-rue 209, 218-219
mealy-mat 209
Meconopsis 263-264, 319
melon 155
Mertensia 228-229
mesquite 55
Meyer, Frank N. 320
Miller, R. R. 10
Mimulus 229, 263-264
Mitchella 220, **222**, 307
Mitella 219
moccasin-flower 308
mock-orange 15, 50, 123
Moneses 192
monkey-flower 229, 263-264
Morus 13
moss 307-308
  club- 307
  peat 310
  -pink **183**, 201-202, **224-225***, 237, 260
mountain-heath 253
mountain-laurel 136, 137
mountain scorpion-weed 228
Muehlenbeckia 232
mulberry 13
Mullison, W. R. 53
Muscari **235**, 245
mustard 40, 48
Myosotis 260
myrtle
  crape- 15
  sand- **251**
Narcissus **211, 213**, 235
Narthecium 309
native northeastern plants for the rock garden **218**
Nearing, G. G. 309
nectarine 119, 322
Neillia **315-316**
Nepeta 201, 260
Nickell, Louis G. 40, 58
ninebark **123**
nursery stock, stored, preventing sprouting of 17
oak 9, 324
  poison- 46
oat 48, 290
Ocimum 248
Oenothera 200, 261
olive 185
onion 48
  weeding **107**
  wild 48, **107**
Onosma 208
Opuntia **210-211**
orange
  mock- 15, 50, 123
  Osage- 129
  preharvest drop control 6, **29-31**, **101**
oranges, "tying," on the tree **29-31**
orchard grass 46
orchid 229, 304, 309-310
orchis **309**
Origanum 233, 246
Ornithogalum 235
O'Rourke, F. L. 151-152
Osage-orange 129
Overbeek, J. van 32-34
Oxyria 228
Pachistima 253
pachysandra 15, 199, 217
Paeonia **216-217**
paint-brush 228
painted-cup 228
palm 270-**271**
pansy 176, 305
Papaver 200, 229
parsley 175, 228, 248
partridge-berry 220, **222**, 307
pasque-flower **204, 206**
peach 14, 17, 119, 167, **170**-172, **283-284**
peanut 48
pear 17, 120, **283-285**
  hormones for 26, 101
  prickly- **210-211**
peat moss 310
Pedicularis **228-229**
Pelargonium 236
Penstemon 201, 204, 215, 228-229, 250, 264
peony **216-217**, 316
periwinkle 199, 211, 217
Pesman, M. Walter 190
pests, rock garden 265-269 (correction, end of index)
Petrophytum 252
Petroselinum 248
petunia 15, 305
Phacelia 228
Philadelphus 50, 123
Philodendron 270-271
Phlox 15, **183**, 199, **201-203**, 207, 213, **224-225***, 227, 237, 243, **260**, 305
photinia 15, 120

Phyllodoce 253
Physocarpus 123
Picea **141**, 143
Pieris 136
Pimelea 240
pincushion, purple 228
pine 9, **140-143**, **183**, 228, 282, 308, 320, 324-325
  ground- 306
  umbrella- 189
pineapples and hormones 32-34
pink **200-201**, 204, 209, **237-238**, 260
  cushion- 227
  grass- 309
  moss- **183**, 201-202, **224-225***, 237, 260
  wild 204, 237
Pinus **140-143**, **183**, 320, 325
pipsissewa 306-307
pitcher-plant **310**
plane-tree 185
plantain 40, **43-45**
  rattlesnake- 222
plant bug **266**
plant hunters **314**
plastics, air layering **298**
plum **172**, 174, 282-283
Plumbago 234
plume-poppy 189
Plumeria 271
poison-ivy **spring cover**, 41, **46-48**, 109
poison-oak 46
poison sumac 46
Polemonium 201, 228
polygala 219
Polygonum 226
Polypodium (polypody) 223
Polystichum **223**
pool **179**, **181**, **185**, **192-193**, **244**
poplar 11, 12, 121, 123
poppy 200, 229
  blue 319
  -mallow 260
  plume- 189
  Welsh- 263-264
Popular Gardening 293, 298
Populus 11, 12, 121, 123
potatoes
  stored, retarding sprouting of **17**, 48, 102
  weeding 52
Potentilla 200, 204, 206, 229
prickly-pear **210-211**
PRIDHAM, A. M. S. 119
primrose 201, **206-207**, 227, 229, **236**, 260, 263-264, **318**-319, 321
  evening- 200, 261
Primula 201, **206-207**, 209, 215, 227, 229, **236**, 260, 263-264, **318-319**, 321
prinsepia 321
privet 120, 123, 125-127, 129, 136-137, **174**, 325
propagation of rock garden plants by cuttings 258-**261**
pruners **115**, **118**
pruning **115-174**
  mechanics **115-118**
  renewal **122**
  restrictive **138**
  some principles **161**
Prunus **7-8**, 119-120, 122, **282-286**, 320-321, 325
pussys-toes 227
Pyracantha 120, **138**
pyrola 229, 307
Pyrus 120
quack grass 40, **48**, **58**
quince 283-285, 324
  flowering 9, 15, 119, 123
radish 41
ragweed 40, 46, **47-48**
ramonda 240, **262**, **264**
Ranunculus 206, 229
RASMUSSEN, E. J. 169
raspberry 49, **155-158**, **173**
rattlesnake 222
reading list 326-330
redbud 9
redtop 46
Rhodes grass 322
rhododendron 15, **136-137**, 195, 214, 253, 299, 314, 317-318, 320
Rhus 122-123, 271
rice 48
  -flower 240
RIES, VICTOR H. 196, 210
rock-cress **183**, 199, **202-203**, 233, 236-237, 260
rock garden handbook **178-269**
rock-jasmine 201, 206-207, 227, 240, 321
ROCK, JOSEPH F. 320
rock-mat 252
rocks in gardens **178-183**
ROCKWELL, F. F. 301
Rocky Mountains, alpine plants from **225-229**
rooting cuttings 14-15, 102
root pruning **147-153**
Rosa 120, 123, 130, 216, 318, 320
rose 15, 17, 50, 120, 123, **130-132**, 215-216, 305, 314, 318, 320
  Christmas- **215-216**, 234
  crown 229
  Lenten- 215, **231**, 234
  sun- 200, 238, 250, 260
rosemary **230-232**, 252
Rosmarinus **230-232**
rotting of alpines in winter, prevention **214**
rue, meadow- 209, 218-219
Russian-thistle 48
Rydbergia 226
saffron 247
sage 15
St. Johnswort 200, 251, 26
  263
Salix 122, 229
Sambucus 123
sand-myrtle **251-252**
sandwort **199-200**, 205, 22
  260
Sanguinaria 218-219
Sanguisorba 247
Santolina 232, **248**, 260
Saponaria 201, **217**, 260
Sarracenia **310**
sassafras **54**
Satureja 201, 232-233, 24
  252
savory 201, 232-233, 247, 25
saw **summer cover, 117-11**
Saxifraga (saxifrage) 19
  204, 206, 208-209, 219
  220, **224-225***, 227-22
  236, 260
SAX, KARL **282**
Schizocentron 240
Sciadopitys 189
Scilla **232**, 235, 245
scorpion-weed, mountain 22
sedge 310
Sedum 192, 199-**201**, 205
  206, 209, 211, 215, **217**
  224-225*, 226-227, 229
  251, 260-**261**
Sempervivum 201-**203**, 205
  211, 215, **224-225***, 260
Senecio **224-225***, 229
sequoia 297
Serissa 232
  shade, pruning **115-124**
  136-151
shears, lopping **116-117**
SHEPHERD, ROY E. 130
shield fern 222
shinleaf 192, 229
shooting star 261
SHOUPP, FREDA J. 246
shrubs
  deciduous, pruning **119**
  124
  flower buds **169-173**
  for rock garden **249-253**
Silene 199, 201, 204-205
  227, 237
silver bell 15
SKINNER, HENRY T. 136
skunkweed 228
sky-pilot 228
skyrocket 227
slug **268**
smoke-tree 121
snakeroot 218, 222
snapdragon 15, 176
snowdrop 235, **242**, 244
snow-in-summer **183**
snow-lily 229
soapwort 201, **217**, 260

soils in the rock garden 194
Soldanella 240
Sorbaria 315
sorghum 322
sorrel, mountain- 228
South, rock gardening **230-235**
soybean 48, 322
Spanish-shawl plant 240
speedwell **179**, 201, **203**, 205, 234, 245, 260
sphagnum 309-310
spider, red **265**
spike-heath 252
spinach 291
spindle-tree 123
Spiraea 15, 120
spirea 9, 120, 171
  false- 315
spittle bug **267**
spleenwort 222-223, 307
sprayer **20, 42, 45, 55, 91**
spring beauty **218**-219, 228
sprouting in storage, prevention, **17**, 48, 102
spruce **141**, 143, 174, 282
spurge, Japanese 199, 217
squill **232**, 235, 244-245
star-flower, spring **231**, 235
star-of-Bethlehem 235
steps, stone **178-181**, **203**
sterility causes **36**
Sternbergia 235, **243**, 245
stewartia 15
STEWART, VIRGINIA 236
STEWART, WILLIAM S. 29
stone-cress 201, **208**
stonecrop 192, 199-**201**, 205-**206**, 209, 211, 217, **224-225***, **226**-227, 229, 251, 260-**261**
stone-fruits 120, 122
stop, thief! **293**
strawberry
  -geranium 199
  weeding 49, 50-52, 107
stump spraying **54-55**
sumac 46, 122-123
summer-lilac 316
summer pruning 166
sundrop 200, 261
  sun- 200, **238**, 250, 260
SUTCLIFFE, ALYS 241
sweet gum 13
sycamore 126
Syringa 50, 122-123
Taraktogenos 321
Taxus 122, **127**, **139**, 325
TAYLOR, T.M.C. **331**
ea 316
terrarium, woodland **307-308**
Teucrium **180**, 252
Thalictrum 209, 219
thief, stop **293**
thinning out a shrub **120**
thin-wood pruning **164-165**
thistle **226-227**
  Russian- 48
Thlaspi 228
thoroughwort 222
thrift **181**, **203**-204
thrips **266**
Thuja 49, **140**, **143**
thyme (*Thymus*) 175, **181**, **199**-201, 205, 213, 232, 235, 239, 246-247, **249**, 252, 260
Tiarella 219, **223**
timothy 46
toadflax 201
tomatoes 175
  and hormones in different areas 20
  early, hormone spray **19**
  grown on fence **154-155**
  seedless **18-20**, 101
Toxicodendron 271
trailing arbutus 305
transplanting, pruning for **147-151**
Trapa 56
tree
  flower buds **169-173**
  fruit, pruning **115-124**, **152-153**, **161-173**
  -of-heaven 11, **13**
  pruning for transplanting **147-151**
  shade, pruning **115-124**, **136-151**
  transplanting **147-151**
trees, crooked, good **323-325**
Trifolium 229
Trollius **229**, 261, 319
trumpet-vine 119
Tsuga **128**, 325
TUKEY, H. B. 142, 161, 166
tulip **212**, **216**, 243-244
tung-oil-tree 322
Tunica 201, 205
tunic-flower 201, 205
tupelo 324
turnip 291
2,4-D, various uses 6
Ulmus 122, 320
umbrella-pine 189
Vaccinium 251, 253
verbena 15
Veronica **179**, 201, **203**, 205, 215, 234, 245, 260
Viburnum 122, 136, 316-318
Vinca 199, 211, 217
Viola 201, 219, 260
violet 201, 219, 260, 305, 307-308
  African- 15, 302
  dogs tooth- 229
Vittadinia 235
VRADENBURG, G. A. 101
wahoo 121
walking fern 222, 224
wallflower 229
wall garden **autumn cover**, **182-184**, **196-201**, **230**
wall, rock, slope **197**
WARD, F. KINGDON 319
water-chestnut 56-57
water-hyacinth **56-57**
water in rock garden 194
water weeds **56-57**
wedge pruning **162-163**
weed control chemicals 40-111
weeds, 454, control **58-111**
weigela 15
WEISS, FREEMAN A. 295
Welsh-poppy 263-264
WESTER, HORACE V. 7
wheat 48
wild garlic 48, 50
wild lettuce 40
wild onion 48, 107
wild pink 204, 237
willow 53, 122, 228-229, 325
WILSON, ERNEST H. 315
window box with fir trimmings **143**
wintercreeper 211
wintergreen 220, **222**, 260, 307, 319
wire grass 280
wire-vine 232
wireworm **269**
wisteria 324
WISTER, JOHN C. 311
wood fern 222-223
wood nymph 192
woods, bring in, winter **306**
Woodsia 224
wormwood 233, 260
WYMAN, DONALD 125
yarrow 200, 204-205, 228, 233, 237
yew 15, 122, **127**, **139-140**, 325
yucca 189
Zephyranthes **232**, 235
zephyr-lily **232**, 235
ZIMMERMAN, P. W. 56
zinnia 305
zoysia 280

CORRECTIONS:

p. 129: legend for lower figure, after "at the" should read "Central Experimental Farm, Ottawa, Ontario, Canada" (with apologies to Dr. Wyman).

p. 265: third paragraph, last sentence should read "Either a 1 per cent gamma isomer dust of lindane, or a spray consisting of 1½ level tablespoonfuls of 25 per cent lindane wettable powder in 1½ gallons of water will also give effective aphid control" (with apologies to Dr. Davidson).

BROOKLYN BOTANIC GARDEN

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